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Volume 4, Number 5, 1922

Serial Number 21

Edited by  
WALTER S. HUNTER  
University of Kansas

## Heredity of Wildness and Savageness in Mice

BY  
CHARLES A. COBURN

Published by  
WILLIAMS & WILKINS COMPANY  
Mount Royal and Guilford Avenues  
Baltimore, U. S. A.

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# BEHAVIOR MONOGRAPHS

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## HEREDITY OF WILDNESS AND SAVAGENESS IN MICE

### INTRODUCTION

For many years, especially since the appearance of Galton's work on the inheritance of mental abilities (1869), students of heredity have recognized the possibility that mental characteristics are inherited as well as the physical and, perhaps, in a somewhat similar way. The later studies of Galton (1897), and those of Woods (1906), Pearson (1903), Ellis (1904), Bentley (1909), Davenport (1896), Goddard (1911), Conklin (1915), and others tend to substantiate the hypothesis of the inheritance of mental traits.

All of these studies, however, pertain to the heredity of mental or moral characteristics in mankind, and the data from which the studies were made were obtained from various historical and observational sources. In 1910 Professor Robert M. Yerkes began an investigation of the hereditability of savageness, wildness, and timidity in rats (1913). So far as the writer has been able to ascertain this was the first study in mental heredity to be made in a laboratory where the conditions under which the subjects lived could be controlled to some extent. The rats used in this study numbered 300 and consisted of wild rats, tame rats, first generation hybrids obtained from crosses of the wild with the tame rats, and the second generation hybrids procured by crossing the first generation among themselves. The investigation, though incomplete, proved conclusively that these three characteristics, wildness, savageness, and timidity are heritable in rats.

In order to gain more definite information concerning the modes of transmission of such behavior-complexes as the above, the writer, at the suggestion of Professor Yerkes, undertook the investigation described in this paper. Owing to the limited space in the Harvard Psychological Laboratory mice were used instead of rats. The study was begun in December, 1911, and continued without interruption until May, 1914. The

number of mice used was about 1300 and consisted of wild mice, tame mice, and hybrids of the first, second, and third generation.

Professor Yerkes mentioned in the report of his investigation the difficulty he experienced in always being sure he was distinguishing between wildness and timidity in rats. He says: "It is indeed extremely doubtful whether it can with sufficient certainty be distinguished from wildness to render measurements significant." The characteristics of rats are so different from those of mice that it would be all the more difficult to make this distinction in the case of the latter. For this reason timidity was omitted in this study and only the two behavior-complexes, wildness and savageness, were investigated.

#### MATERIAL AND METHODS

From the beginning of the work in December, 1911, until June 7, 1913, the mice were kept in one of the large, well-ventilated rooms of the Harvard Psychological Laboratory. Upon the latter date the mice were taken to the Franklin Field Station at Franklin, New Hampshire, where the excellent facilities allowed even greater progress during the summer than in the quarters at Harvard although in no way were the methods of the experiment changed. Upon the return from the Franklin Field Station in October, 1913, the study occupied one of the rooms of the newly-completed Harvard Laboratory of Animal Psychology where it remained until the completion in May, 1914. This room was well lighted through the glass ceiling but possessed no direct connection with the outside, hence had to be ventilated by a system of fans. This, however, seemed to have no effect upon the work as the mice thrived equally as well here as in the former quarters.

In the beginning the mice were kept in the large cages used by Professor Yerkes in his work with the dancing mice (1907) from the report of which a description may be obtained. Later, when the large number of mice compelled the use of more cages, the type of cage used by Professor William E. Castle and his associates at the Bussey Institute, Forest Hills, Mass., was adopted. A description of this cage, to the knowledge of the writer, has never been printed. It is made entirely of woven wire of one-quarter inch mesh and is, in form, a truncated rec-

tangular parallelepipedon, the truncation beginning at a line in the top 8 cm. from the back side and extending to a line in the front side 8 cm. from the bottom. The bottom of the cage is 30 cm. long by 21 cm. wide; the back, 21 cm. wide by 21 cm. high; the portion of the top parallel with the bottom and the portion of the front parallel with the back are each 8 cm. by 21 cm. The slanting surface comprising the remaining part of the top and front is 26 cm. long by 21 cm. wide. The two remaining sides of the cage are five sided, the measurements of each being 30 cm. by 21 cm. by 8 cm. by 26 cm. by 8 cm. In the slanting surface, 8 cm. from the top and bottom and 5.5 cm. from each side, is the door 10 cm. by 10 cm. The lid is 12 cm. by 12 cm. hinged at the top.

The very convenient watering system in use at the Bussey Institute was also adopted. It consists of a 10 or 12 ounce bottle fitted with a perforated rubber cork through which is passed a small glass tube bent at an angle of about 120 degrees so that when the bottle is placed upon the slanting surface of the cage the tube will extend down through the wire of the fore part of the cage to within easy reaching distance from the floor of the cage. The lower end of this tube is slightly drawn together so the water will not flow of its own accord. The mice soon learn to drink drop by drop from the tube. Thus there is a constant supply of clean water without the evil effects of a wet cage as when the water is placed in a receptacle on the floor or side of the cage. The bottle serves also as a weight on the lid of the cage making it impossible for the mice to escape in this way.

When in use these cages were placed upon wooden shelves which were covered with sufficient sawdust to well cover the bottom of the cage. This sawdust would remain on the shelf when the cage was raised and so could be replaced with fresh sawdust without greatly disturbing the mice.

Shredded tissue paper was used as bedding for the mice and, since it was the purpose of the experiment to minimize as much as possible the effect of the presence of the experimenter while cleaning cages, feeding or testing the mice, there was always sufficient paper in the cage to enable the mice to hide in it if they so wished. Until all the tests were made the mice were seldom handled or otherwise greatly disturbed except when being tested.

It was found that the Bussey Institute cage was very much more adaptable for the breeders than for testing purposes hence when the mice were weaned they were separated according to sex and placed in the larger cages and the subsequent tests made from these. Only occasionally, when the number of mice being tested was too great for the supply of large cages were the smaller cages used in this way.

The food for the mice consisted of cracked corn, oats, sunflower seed, bread moistened with milk, and occasionally a bit of lettuce or other green food. In the beginning some difficulty was experienced in so regulating the food to keep the mice, especially the breeders, in the best condition. The first few months' experience, however, was sufficient to obviate this difficulty.

The method of testing used by Professor Yerkes was followed in this study as closely as was possible. The mice were classified according to the six grades, namely, 0, 1, 2, 3, 4, 5. The grade 0 indicates the absence of all evidences of wildness or savageness, and the grade 5 indicates the presence of all the various signs of wildness or savageness in the greatest number and intensity. After a few mice were tested definite standards which represented the various grades were fixed and there is fairly definite evidence to indicate that these standards were adhered to throughout the investigation. Every few weeks an additional test was made of several mice which had been tested a day or two previous along with so great a number that it would be impossible to remember the grade of any mouse. In making these check tests the mice were taken at random from the different cages and after testing them a comparison would be made of the results of this test and the one immediately preceding. The grading varied occasionally but rarely more than one grade. The results given below were chosen at random and are typical of such tests.

The mice were weaned, given their initial test and numbered when they were about five or six weeks old. The age varied somewhat in order to allow several litters to be grouped and thus facilitate the work. At this age the mice are not full-grown but they have full use of all their organs of sense and are very active.

NUMBER OF MOUSE	DATE	GRADE OF WILDNESS	GRADE OF SAVAGENESS
512 ♀	April 9 April 11	5 5	5 5
517 ♂	April 9 April 11	5 5	3 4
990 ♂	January 20 January 22	3 3	3 4
1002 ♀	January 20 January 22	4 4	4 4
1008 ♂	January 20 January 22	1 1	1 0
1040 ♂	January 20 January 22	3 4	2 2

In order to avoid any effect which a change of surroundings and a possible change of temperature or light may have upon the behavior of the mice, all testing was done in the room occupied by the mice. The cage containing the individuals to be examined was placed upon the testing table which was located, as a rule, in one corner of the room. Upon the table were also placed paper, pencil, paper punch for marking the mice, and a pair of placental forceps over the jaws of which had been placed soft rubber tubing in order to lessen the pressure and also the chances of injuring the tail of the mouse which required its use in catching. The gloves worn by the experimenter while testing were of kid of medium thickness.

Removing the mouse from the nest was done, when the mouse was hiding in the nest, by gently pushing back with the left hand the shredded tissue paper of the nest until the tail was exposed and then, grasping the tail between the thumb and forefinger, the mouse would be equally as gently pulled from the nest and at the same time placed upon the palm of the hand by turning the palm upward. In this way the mouse could often be removed without greatly disturbing it. When the smaller Bussey Institute cage was used, since the door was so small, often the tail when exposed had to be grasped by the placental forceps and thus the mouse pulled from the nest and placed upon the palm of the hand. When the mouse to be removed was not hiding in the nest the forceps were used to

grasp the tail and hold it only until it could be grasped by the fingers of the left hand whereupon the removal would proceed as usual. It is to be noted that the forceps were used as little as possible since the chance of unconsciously using unnecessary pressure was much greater with the forceps than with the fingers. The mouse was allowed to remain on the palm of the hand for a moment while a definite impression of its behavior was obtained. Then with the tail between the thumb and forefinger of the right hand and the mouse on the palm of the left or being gently held in the left hand the sex would be determined. This done the mouse would be returned to the position on the palm of the right hand and one of the fingers of the left hand or a pencil would be moved fairly rapidly up and down just before the mouse, the experimenter at the same time making a clicking sound with his tongue and teeth. The object of this was to get the behavior of the mouse when excited if such was possible. This completed the testing observations in the case of the initial tests and, the judgment being made, the result was thereupon entered. In the subsequent tests the behavior of the mouse when released was noted before making the judgment. The mouse was then numbered and placed in a cage with others of like sex and, as nearly as possible, like age in order to prevent promiscuous breeding and the killing of the younger mice by the older.

The system of numbering was identical with that in use at the Bussey Institute. It consisted in making certain notches or holes in the ears of the mouse. When viewed from behind the number indicated on the right ear represented the units and that on the left ear the tens of any particular number. Absence of any mark indicated zero. 1, 2, 3, etc. were respectively designated as follows: hole in the upper side of ear, hole in outer side, hole in lower side, notch in upper edge, notch in outer edge, notch in lower edge, notches in upper and outer edges, notches in outer and lower edges, notches in upper and lower edges. Ten was indicated by a hole in the upper side of left ear and nothing in the right ear, 22 by a hole in the outer side of both left and right ears, etc. The wounds thus made were usually observed to be completely healed in a very few days. By such combinations any number up to and including 99 could be indicated. As the different hundreds were desig-

nated on the outside of the cages and a description of each mouse was taken at the time of the first test, no difficulty was ever experienced in determining the identity of any mouse which had escaped from its cage. It may be mentioned that it was necessary to make the rooms occupied by the mice rat proof as well as mouse proof. In the beginning sufficient caution was not taken in this respect the result being that many mice were killed by rats and others lost by escaping from the room after they had by some chance escaped from their cage.

The following is the record of the initial test of one litter. The records of the subsequent tests were kept similarly except the omission of the description of the mice and the number of their parents.

*June 18, 1913. F3's from F2 409 ♀ and F2 440 ♂. Born April 29, 1913*

NUMBER OF MOUSE	DESCRIPTION	WILDNESS	SAVAGENESS
581 ♀	Chocolate, black eyes	4	3
582 ♀	Gray	3	3
583 ♂	Chocolate, red eyes	3	3
584 ♂	Chocolate, red eyes	4	4
585 ♀	Chocolate, black eyes	4	5

The types of behavior which were considered the chief indications of wildness in mice and were relied upon as a basis for grading were as follows.

1. Hiding from view in the cage just before the test or immediately after, and attempts to hide from view in the hand during the test. A wild mouse, though it may be feeding in the open in the cage while the experimenter is moving about the room or standing before the cage, will scurry to the back of the cage and hide in the nest at the first move of the experimenter to open the door of the cage. A tame mouse, on the other hand, will continue eating and is easily caught, in fact, it will rarely make any attempt to prevent it. When the wild mouse has been caught it is continually trying to find some crevice between the fingers in which it may hide. If it succeeds in covering its head it will often remain perfectly quiet as long as it is allowed to maintain this position.

2. Running and jumping excitedly about the cage just before being caught and attempts to escape from the hand after being

caught. Often the wildness is sufficiently great that the mouse apparently forgets to hide in the nest at the first move to open the door of the cage, or it may have hidden there but at the first touch of the hand on the outside of the nest it will jump from the nest and begin to run frantically about the cage and finally try to hide in the upper far corner of the cage or it may continue to run about the cage until caught. When one with such wildness is caught it continues to try to escape, jumping about the hand and trying energetically to pull its tail loose. After some time it may become quiet but will immediately resume the attempts to escape at the slightest move of the experimenter, especially if the pressure of the fingers on its tail is somewhat lessened.

3. Squeaking. This was rarely observed except in very young mice or older mice when they were being graded for the first time. However it is included as an indication of wildness since it was never observed in tame mice.

4. Urination and defecation. Both of these are associated with the greater degrees of wildness. They were used in grading only in a general way.

5. Jumping from the hand when released and immediately hiding in the nest or excitedly running about the cage. When a very wild mouse is being put back in the cage it will immediately jump from the hand the instant the pressure on its tail is released. It usually jumps straight ahead no matter whether that is toward the top, side or front of the cage, or directly through the door of the cage toward the experimenter. If it alights in the cage it generally dashes toward the nest and hides. At other times it may run about the cage but sooner or later will seek the nest. A tame mouse will never jump in this way. It will go to the edge of the hand and look down. If the distance is very great it will try the other side and will not of its own accord leave the hand unless it can reach the floor with its fore feet when it hangs over the side of the hand. When it is safely back in the cage it makes no attempt to hide.

Professor Yerkes found that there are two kinds of savageness in rats. These he termed defensive and offensive. Only the former is found in mice. The most savage mouse will never attack the observer nor make the slightest move to do so. It will only bite when it is caught and unable to get loose.

Biting in this case is not, however, always a sign of savageness. Quoting from the writer's notes; "Biting when just caught is not always a sign of savageness for tame individuals will bite if hurt." This is corroborated by Miss Abbie E. C. Lathrop, Granby, Mass., who has had many years' experience in breeding and handling mice. The following statements are taken from one of her letters. "Every one who comes here and tries to handle mice gets bitten even by tame mice, because of grasping the tail too tightly. Some mice are cross even when not hurt, but gentle mice resent pain and bite."

The chief indications of savageness are biting and squeaking. A mouse possessing the greatest degree of savageness may indicate this by biting in either of two ways depending largely, it seems, upon the degree of wildness which accompanies it. Very often a very savage mouse while being pulled from the nest and before the hand has touched its body will swing about and sink its teeth into the glove. This act is the nearest approach to the offensive savageness of the rat. If there is a great degree of wildness present which will cause it to make violent attempts to free itself, everytime that its feet touch a part of the glove in its frightened jumping about the teeth are vigorously used. Often in the instant before the next jump two or three bites will be made in the glove, the mouse trying, as it were, to find some vulnerable spot. If the glove has even a small hole in it in an accessible spot the mouse of this type is very apt to find it and use its teeth with considerable effect.

On the other hand, if there is a much less degree of wildness present the mouse will often seize the glove with its teeth and tenaciously hold on until compelled to let go by the experimenter whereupon it will immediately fasten its teeth in another part of the glove. The mouse with no savageness will make no attempt to bite even when teased unless the tail is held too tightly or it is otherwise hurt. However, many of the non-savage mice made no attempt to bite even when being numbered.

Between these two extremes of savageness there are many types of behavior which were considered as representing different grades of savageness as, for instance, the mouse with a low degree of savageness will, perhaps, use its teeth but once or twice during the test and then only in an indifferent way,

or it may not bite at all until it is teased whereupon it will do so vigorously for an instant or two.

Squeaking is an indication of a fairly high degree of savageness unless the mouse is hurt, in which case it may be observed where there is little or no savageness.

Although the types of behavior mentioned above are the chief indications of wildness and savageness in mice, a great many others which are very significant often appear. The range of individuality of mice, to the experienced observer, is very great. In spite of these many indications and the different degrees of intensity with which they appear in the behavior of mice during a test, very rarely did the writer, after he had had some experience, have difficulty in forming a judgment of the grade of wildness or savageness observed.

A description of the wild and tame mice used in this study is given in table 1.

The observations and tests made on the tame mice from the Bussey Institute and Miss Abbie E. C. Lathrop for some time after they arrived at the laboratory indicated in no case a grade of wildness or savageness above 0. The mice from the Bussey Institute were from a strain which had been in use there for some time for various color and structural studies and were from stock which had originally been obtained from Miss Lathrop. After they had been used in the present study for about a year, it was quite accidentally learned that there was some possibility of their possessing some wild blood as mice from this strain had at various times been crossed with wild in the color studies. In order to secure more definite information a mating was made from these mice and the offspring tested. The results are shown in table 2.

The table gives in the upper left hand corner (*a*) the average number of tests; (*b*) the range of tests; (*c*) the average age at the time of the first test; (*d*) the average age for the last test; immediately below, (*e*) the number of mice and sex; to the right of this, (*f*) the average grade attained in the first test for wildness; (*g*) the average of the first and second tests; (*h*) the average of all the tests; (*i*) the average of the third, fourth and fifth tests; (*j*) the average grade attained in the last test. Immediately to the right of these averages is presented the distribution of the mice in the grades 0 to 5. The averages for

the tests for savageness and the distribution of the mice in grades for savageness are presented in like manner.

TABLE 1  
*Parental Generation*

MOUSE	DESCRIPTION	WHERE OBTAINED
1 ♀	Chocolate, tame	Bussey Institute, Forest Hills, Mass.
2 ♂	Chocolate, tame	Bussey Institute, Forest Hills, Mass.
6 ♂	Chocolate, tame	Bussey Institute, Forest Hills, Mass.
7 ♂	Chocolate, tame	Bussey Institute, Forest Hills, Mass.
501 ♀	Chocolate, tame	Miss Abbie E. C. Lathrop, Granby, Mass.
502 ♀	Chocolate, tame	Miss Abbie E. C. Lathrop, Granby, Mass.
503 ♀	Chocolate, tame	Miss Abbie E. C. Lathrop, Granby, Mass.
504 ♂	Chocolate, tame	Miss Abbie E. C. Lathrop, Granby, Mass.
522 ♀	Cream, tame	Miss Abbie E. C. Lathrop, Granby, Mass.
523 ♀	White, tame	Miss Abbie E. C. Lathrop, Granby, Mass.
524 ♀	White, tame	Miss Abbie E. C. Lathrop, Granby, Mass.
525 ♀	Black, tame	Miss Abbie E. C. Lathrop, Granby, Mass.
527 ♀	White, tame	Miss Abbie E. C. Lathrop, Granby, Mass.
528 ♀	White, tame	Miss Abbie E. C. Lathrop, Granby, Mass.
529 ♀	Chocolate, tame	Raised in laboratory, parents, 503 ♀ and 504 ♂
530 ♂	Chocolate, tame	Raised in laboratory, parents, 503 ♀ and 504 ♂
531 ♀	Chocolate, tame	Raised in laboratory, parents, 503 ♀ and 504 ♂
532 ♀	Chocolate, tame	Raised in laboratory, parents, 503 ♀ and 504 ♂
533 ♂	Chocolate, tame	Raised in laboratory, parents, 503 ♀ and 504 ♂
534 ♂	White, tame	Miss Abbie E. C. Lathrop, Granby, Mass.
652 ♀	White, tame	Miss Abbie E. C. Lathrop, Granby, Mass.
3 ♀	Gray, wild	Dwelling-house, Cambridge, Mass.
4 ♀	Gray, wild	Dwelling-house, Cambridge, Mass.
5 ♀	Gray, (Singer) wild	Dwelling-house, Chestnut Hill, Mass.
8 ♂	Gray, wild	Dwelling-house, Cambridge, Mass.
225 ♀	Gray, wild	Emerson Hall, Cambridge, Mass.
346 ♂	Gray, wild	Morgan Memorial, Boston, Mass.
348 ♀	Gray, wild	Morgan Memorial, Boston, Mass.
472 ♂	Gray, wild	Dwelling-house, Brooklyn, New York
474 ♂	Gray, wild	Dwelling-house, Brooklyn, New York
475 ♀	Gray, (Singer), wild	Dwelling-house, Brooklyn, New York
510 ♂	Gray, wild	Raised in laboratory, parents, 225 ♀ and 350 ♂
511 ♀	Gray, wild	Raised in laboratory, parents, 225 ♀ and 350 ♂
512 ♀	Gray, wild	Raised in laboratory, parents, 225 ♀ and 350 ♂
513 ♀	Gray, wild	Raised in laboratory, parents, 225 ♀ and 350 ♂
514 ♀	Gray, wild	Raised in laboratory, parents, 225 ♀ and 350 ♂
515 ♂	Gray, wild	Raised in laboratory, parents, 225 ♀ and 350 ♂
516 ♀	Gray, wild	Raised in laboratory, parents, 475 ♀ and 474 ♂
517 ♂	Gray, wild	Raised in laboratory, parents, 475 ♀ and 474 ♂
518 ♂	Gray, wild	Raised in laboratory, parents, 475 ♀ and 474 ♂
519 ♀	Gray, wild	Raised in laboratory, parents, 475 ♀ and 474 ♂
520 ♂	Gray, wild	Raised in laboratory, parents, 475 ♀ and 474 ♂
521 ♂	Gray, wild	Raised in laboratory, parents, 475 ♀ and 474 ♂
350 ♂	Gray, wild	Emerson Hall, Cambridge, Mass.

As is readily seen from the table there was undoubtedly some trace of wild blood in these mice, but the amount was so small that all evidence of its presence was effaced by the time the

mice were 110 days old. The wildness and savageness had evidently been counteracted by the taming effect of the daily presence of the experimenter while feeding and cleaning the cages, and the handling during the five tests. The degree of savageness was only about half as great as that of wildness and did not persist as long, since after the second test the grade for savageness was in no case above 0. Another point which should be mentioned here but which is not shown in the table is the difference in the degree of wildness and savageness of the males and females. If the average of all the five tests is used as a criterion, the females were about twice as wild and savage as the males since the average grades for wildness and

TABLE 2  
*Summary of Results for One Litter of Offspring of Mice from Bussey Institute*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades						Distribution of mice in grades						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 5													
Range of tests, 5													
First test.....	2.6		1	1	2	1		1.8		2	2	1	
Average age in days:													
First test, 46													
Last test, 110													
Average 1 and 2.....	2.1			4		1		1.1		4		1	
Average all.....	1.01		4	1				0.44	4	1			
5 mice													
(3 males and													
2 females)													
Average 3, 4 and 5....	0.53	3	2					0.0	5				
Last test.....	0.0	5						0.0	5				

savageness, respectively, were 1.8 and 0.6 for the females in contrast with 0.73 and 0.33 for the males.

As a result of this evidence of impurity in the tame mice, 2 males and 10 females were obtained from Miss Lathrop. Before these were used, however, a mating was made from them and the offspring tested as in the previous instance. There was not a mouse in any of these tests which received a grade above 0 in either wildness or savageness. The proof of the purity of the tameness and non-savageness of these young mice (table 1, nos. 529 to 533 inclusive), and their parents was considered so conclusive that there was no hesitation in assuming an equal purity in the remaining 10.

The 11 wild mice which were captured and used for breeding purposes in this study were, with the exception of mouse 472 ♂, full-grown when caught. This mouse was judged from 6 to 8 weeks old. All of these mice were tested several times for wildness and savageness and in each test manifested the highest grades. The last test occurred when the time of captivity varied from 1 to 6 months. Each received a grade of 5 for wildness and savageness except two (nos. 225 ♀ and 474 ♂), which were graded 4 in savageness. Although it was necessary to handle these mice when weaning their young or changing their mates, there was during this handling no observation of any behavior which would tend to indicate that their wildness or savageness had decreased to any appreciable degree even after they had been in captivity from one to two years. However, when not being handled there was a very noticeable difference in the degree of wildness. Instead of scurrying to their nest as they did when the experimenter entered the room during their early captivity, later they would, as a rule, remain in the open and continue eating, but it was never possible to persuade them to come to the front of the cage to secure a bit of food from the experimenter's fingers.

The 12 wild mice, nos. 510 to 521 inclusive, were raised in the laboratory and were tested five or six times in the same manner and at regular intervals as the mice of table 2. A summary of the results of these tests are presented in tables 15 and 16. These mice were chiefly used in matings with the tame mice obtained from Miss Lathrop.

Although no more crosses were made between the mice from the Bussey Institute and the wild individuals after the discovery of the apparent trace of wild blood, the series begun by them was continued and the results will be presented in this study. These results, however, will be summarized in separate tables except in such cases where the information to be noted is equally significant in each series.

To avoid any confusion which might otherwise arise the series from the crosses of Bussey Institute mice with wild mice will be termed Series A, and the first, second, and third hybrid generations of this series will be designated,  $F_1a$ ,  $F_2a$ , and  $F_3a$ , respectively. Likewise the series from crossing the tame mice from Miss Lathrop with wild mice will be termed Series B, and the hybrid generations,  $F_1b$ ,  $F_2b$ , and  $F_3b$ .

The first generation hybrids in each series were obtained by crossing wild females with tame males and tame females with wild males. The second generations of hybrids were obtained by crossing the first generation hybrids among themselves without selection as to wildness or savageness, except in the cases where selective breeding was tried, the results of which will be presented in separate tables. Likewise by crossing the second generation hybrids among themselves the third generation of hybrids were obtained.

It was aimed to test each individual five times. However, there was a number which because of death or other reason did not receive that number. Those that received but one test have not been considered in the results. On the other hand, for reasons which will be discussed later, some mice received six to eight tests.

Deducting those individuals used in experiments to determine the effect of age on the lowering of grades of wildness and savageness in the successive tests, the average age for the first test was 38.8 days, and for the fifth test, 92.8 days. The average time between the first and second tests was 17 days; between the second and third, 15 days; between the third and fourth and between the fourth and fifth, 11 days each.

#### EXPERIMENTAL RESULTS

##### *A. General comparison of inheritance in the hybrid generations of both series*

In table 3 is presented a general summary of the results for the three generations of both series. A comparison of the averages in each of the generations shows a very great similarity, the difference in any case being so small as to be practically negligible. However, the difference in the grades of wildness and savageness attained in the first and last test is significant. This lowering of the grades is gradual in each generation but is greatest in both wildness and savageness in the  $F_2$ 's. The model grade, i.e., the grade which is the most frequent, is either 3 or 4 for wildness in each generation, and for savageness ranges from 3 to 5.

In tables 4 and 5 the results of the series are presented separately. The similarities of the averages in the generations so

apparent in table 3 naturally maintain to some extent in the results of each series. There are, however, some differences

TABLE 3  
*Summary of Results for the Three Generations of Both Series*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 4.46													
Range of tests, 2-5													
First test.....	3.95	1	2	2	72	142	75	4.01		3	85	101	103
Average age in days:													
First test	Average 1 and 2.												
35.27													
Last test,													
79.36													
294 F <sub>1</sub>	Average all.....	3.49		16	27	135	16	3.13		5	62	126	75
Males and females	* (285)												
Average 3, 4 and 5.....	3.25	1	42	128	93	21	2.63		9	33	77	91	20
Last test.....	3.16	17	54	117	71	35	2.45		41	38	55	90	23
Average number tests, 4.70													
Range of tests, 2-5													
First test.....	3.89	2	2	9	114	181	102	4.09		2	2	16	92
Average age in days:													
First test	Average 1 and 2.												
40.99													
Last test, 92.39													
410 F <sub>2</sub>	Average all.....	3.50		7	43	192	159	19	3.26		2	9	95
Males and females	* (405)												
Average 3, 4 and 5.....	3.02	5	25	73	164	114	24	2.63		18	71	97	107
Last test .....	2.81	21	32	97	142	89	29	2.13		101	53	67	106
Average number tests, 4.83													
Range of tests, 2-5													
Average age in days:													
First test, 38.09													
First test, 38.09	3.60		2	7	62	75	18	4.07		7	35	40	82
Last test, 88.71													
164 F <sub>3</sub>	Average all.....	3.48			27	64	67	6	3.40		5	25	53
Males and females	* (162)												
Average 3, 4 and 5.....	3.25		7	28	53	61	13	3.13		4	16	31	40
Last test .....	2.98	7	19	20	59	41	18	2.91		22	15	23	40
										23		41	

\* The number of mice that received three or more tests.

to be noted in a comparison of the two series. The averages of the first test and of the first and second tests for wildness in the F<sub>1</sub> and also in the F<sub>2</sub> of both series are practically equal,

but the remaining averages in these two generations of Series B are in each case higher than those of Series A. The summary of the tests for savageness in these two generations indicates

TABLE 4  
*Summary of Results for the Three Generations of Series A*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 4.13													
Range of tests, 2-5													
First test.....	3.98	1	1	21	44	26	3.97	1		23	44	25	
Average age in days:													
First test, Average 1 and 2.....	3.72		3	18	52	20	3.58		1	26	52	14	
31.22													
Last test, 75.61	3.31		5	50	36	2	2.96		24	44	21	4	
93 F <sub>1</sub> a	(90)												
Males and females	Average, 3, 4 and 5.....	2.92		20	50	17	3	2.38	13	32	33	10	2
	Last test.....	2.75	5	30	43	13	2	2.04	8	27	20	30	7
Average number tests, 4.40													
Range of tests, 2-5													
First test.....	3.90		3	52	80	42	3.94	1	13	39	66	58	
Average age in days:													
First test, Average 1 and 2.....	3.72		2	44	90	41	3.46	1	2	15	47	77	35
41.66													
Last test, 98.72	3.05		31	96	46	4	2.64	1	17	55	68	32	4
177 F <sub>2</sub> a	(173)												
Males and females	Average 3, 4 and 5.....	2.52	1	19	49	74	27	3	1.97	12	41	51	14
	Last test .....	2.39	12	25	57	52	26	5	1.67	52	33	36	16
Average number tests, 4.88													
Range of tests, 3-5													
First test.....	3.44	2	7	51	46	8	3.84		7	31	28	48	
Average age in days:													
First test, Average 1 and 2.....	3.41		5	38	59	12	3.63	1	7	32	44	30	
36.76													
Last test, 93.52	3.23		24	44	43	3	3.26	5	19	42	32	16	
114 F <sub>3</sub> a	(114)												
Males and females	Average 3, 4 and 5.....	3.10	5	26	38	38	7	3.01	4	13	20	35	23
	Last test .....	2.79	6	17	15	41	26	9	2.78	18	9	18	29
													14
													26

that the mice of Series B attained a higher average grade in the first test and maintained a greater degree throughout all the tests. Likewise the F<sub>3</sub>b averaged higher grades in both

wildness and savageness than the  $F_3a$ . If the assumption that there was some wild blood in the tame parents of Series

TABLE 5  
*Summary of Results for the Three Generations of Series B*

	WILDNESS						SAVAGENESS								
	Distribution of mice in grades:						Distribution of mice in grades:								
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4	5	
Average number tests, 4.62															
Range of tests, 2-5	First test.....	3.94	1	1	1	51	98	49	4.02	1	3	62	57	78	
Average age in days: First test, 37.18	Average 1 and 2.....	3.83	1	2	29	111	58	3.82		8	45	79	69		
Last test, 81.09	Average all.....	3.56		11	77	99	14	3.20		5	38	82	54	22	
201 $F_1b$	(195)														
Males and females	Average 3, 4 and 5.....	3.36	1	22	78	76	18	2.73	9	20	45	58	45	18	
	Last test.....	3.37	12	24	74	58	33	2.63	33	11	35	60	40	22	
Average number tests, 4.95															
Range of tests, 2-5	First test.....	3.89	2	2	6	62	101	60	4.21	1	2	353	62	112	
Average age in days: First test, 40.66	Average 1 and 2.....	3.75	3	7	43	111	69	3.93		1	11	27	77	117	
Last test, 87.15	Average all.....	3.50	7	12	86	113	15	3.40	1	7	40	59	85	41	
233 $F_2b$	(232)														
Males and females	Average 3, 4 and 5.....	3.32	4	6	24	90	87	21	3.03	6	30	46	55	58	37
	Last test.....	3.12	9	7	40	90	63	24	2.48	49	20	31	70	28	35
Average number tests, 4.70															
Range of tests, 2-5	First test.....	3.98			11	29	10	4.60			4	12	34		
Average age in days: First test, 41.12	Average 1 and 2.....	4.69		1	8	33	8	4.19			4	23	23		
Last test, 77.62	Average all.....	4.07		3	20	24	3	3.74		6	11	21	12		
50 $F_3b$	(48)														
Males and females	Average 3, 4 and 5.....	3.62	1	2	2	15	23	6	3.41	4	3	11	5	18	11
	Last test.....	3.42	1	2	5	18	15	9	3.20	4	6	5	11	9	15

A is correct, these results are directly opposed to the results Professor Yerkes obtained with the rats.<sup>1</sup>

<sup>1</sup> Robert M. Yerkes, The Heredity of Savageness and Wildness in Rats. The Journal of Animal Behavior, iii, No. 4, page 293.

Of the five averages included in the tables, the average of all the tests and the average of the third, fourth, and fifth tests seem to present the most accurate estimates of the degree of wildness or savageness of the mice, because the number of tests included in these averages tends to counteract the effect of any extreme grade of wildness and savageness or tameness and non-savageness that may have been received in an occasional test due to the influence of some extraordinary conditions upon the mouse or the experimenter or both at the time of the test. Of these two averages, that of the third, fourth and fifth tests is probably the more reliable measurement of the traits in question. This is because there is included in the average of all tests the results of the first two tests which are considered to give an exaggerated estimate of the wildness, and perhaps also savageness, possessed by the mouse on account of the possible effect, in the case of the first test, of the experience of being handled for the first time; and, in the case of the second test, because of any effect which may remain from the more or less painful experience of being numbered immediately after the first test is made. The fact that the lowering of the grades of wildness is greater between the second and third tests than between any other two successive tests seems to support this statement (table 12, page 23).

Using the average of all tests and the average of the third, fourth and fifth tests as criteria, the arrangement of the generations of Series A with respect to grades attained in wildness and savageness is (1)  $F_3$ , (2)  $F_1$ , (3)  $F_2$ , where one represents the highest grade and three the lowest grade. This order of arrangement is maintained when the degree of wildness of the generations of Series B is considered, but the order of this series with respect to savageness is (1)  $F_3$ , (2)  $F_2$ , (3)  $F_1$ .

The modal grade for wildness is either 3 or 4 in all the generations of both series except  $F_{2a}$  where it ranges from 2 to 4. The modal grade for savageness is either 3 or 4 in  $F_{1a}$  and either 4 or 5 in  $F_{3b}$ . In the case of  $F_{3a}$ ,  $F_{1b}$ , and  $F_{2b}$ , it ranges from 3 to 5, and in  $F_{2a}$  the range is from 0 to 5.

In tables 6, 7, and 8, the results for the males and females of each generation of Series A are presented separately, and in tables 9, 10, and 11, those of Series B are shown.

The averages for the males and females of  $F_{1a}$  (table 6) indicate but little difference in the grades of wildness and savage-

ness attained by each. The average grades for wildness attained by the males in the first test and in the last test are almost identical with those of the females. But in the case of the averages for wildness in all tests and in third, fourth, and fifth tests, those of the males are a fraction of a grade higher than those of the females. While the averages of the first tests for savageness are somewhat higher for the females than for the males, the average grades attained in the last tests are

TABLE 6  
*Summary of Results for First Generation Hybrids, F<sub>1</sub>, of Series A*

		WILDNESS						SAVAGENESS					
		Distribution of mice in grades:						Distribution of mice in grades:					
		Av.	0	1	2	3	4	5	Av.	0	1	2	3
Average number tests, 3.82													
Range of tests, 2-5	First test.....	4.0		1	10	17	13	3.80	1		13	18	9
Average age in days:													
First													
test, 31.60	Average 1 and 2....	3.74			1	9	21	10	3.45			16	19
Last test, 75.63	Average all.....	3.33			4	19	16	2	2.98		10	19	9
41 F <sub>1</sub> a	(38)												
Males	Average 3, 4 and 5 ..	2.94			12	15	10	1	2.52		5	14	13
	Last test.....	2.75		3	12	19	6	1	2.14	4	11	6	15
Average number tests, 4.19													
Range of tests, 3-5	First test.....	3.98			1	11	27	13	4.11			10	26
Average age in days:													
First													
test, 30.92	Average 1 and 2....	3.70			2	9	31	10	3.68		1	10	33
Last test, 75.59	Average all.....	3.15			1	31	20	2	2.11		14	25	12
52 F <sub>1</sub> a	(38)												
Females	Average 3, 4 and 5 ..	2.92			8	35	7	2	2.36		8	18	20
	Last test.....	2.75		2	18	24	7	1	1.96	4	16	14	15
										2	1		

just the reverse. The grades representing the averages of all the tests are practically equal, 2.98 for the males and 2.99 for the females. The males in the third, fourth and fifth tests for savageness received, as an average, 0.16 grade higher than the females.

The modal grade for wildness of the males and females of F<sub>1</sub>a is either 3 or 4 in each case. The mode for savageness of the males ranges between 2 and 4, and of the females, between 1 and 4.

TABLE 7  
*Summary of Results for Second Generation Hybrids, F<sub>2</sub>, of Series A*

		WILDNESS						SAVAGENESS					
		Distribution of mice in grades:						Distribution of mice in grades:					
		Av.	0	1	2	3	4	5	Av.	0	1	2	3
Average number tests, 4.45													
Range of tests, 2-5	First test.....	4.00		1	21	36	24	4.46		1	15	37	29
Average age in days:													
First													
test, 42.00	Average 1 and 2....	3.67		2	23	40	17	3.44		1	9	22	38
Last test, 99.21	Average all.....	2.93		22	42	16	22	2.54		11	27	31	12
82 F <sub>2</sub> a	Average all.....	(79)											
Males	Average 3, 4 and 5	2.31	16	22	29	11	1	1.79	9	19	23	25	2
	Last test.....	2.10	10	17	22	21	11	1	1.34	35	12	14	15
													5
Average number tests, 4.36													
Range of tests, 2-5	First test.....	3.82		2	31	44	18	4.07	1	12	24	29	29
Average age in days:													
First test, 41.38	Average 1 and 2....	3.76		21	50	24	3.63	1	1	6	25	39	23
Last test, 99.27	Average all.....	3.17		9	54	30	22	2.83	1	6	28	37	20
95 F <sub>2</sub> a females	Average all.....	(94)											
	Average 3, 4 and 5	2.70	1	3	27	45	16	22	1.9	3	22	28	27
	Last test.....	2.64	2	8	34	31	15	4	2.00	17	21	22	11
													3

TABLE 8  
*Summary of Results for Third Generation Hybrids, F<sub>3</sub>, of Series A*

		WILDNESS						SAVAGENESS					
		Distribution of mice in grades:						Distribution of mice in grades:					
		Av.	0	1	2	3	4	5	Av.	0	1	2	3
Average number tests, 4.80													
Range of tests, 3-5	First test	3.38		2	5	26	25	4	3.95		4	19	15
Average age in days:													
First													
test, 35.06	Average 1 and 2....	3.30		5	22	28	7	3.66	1	4	13	27	17
Last test, 89.74	Average all.....	3.07		16	24	20	2	2.99	4	13	22	17	6
62 F <sub>2</sub> a													
Males	Average 3, 4 and 5	3.08	3	17	20	17	5	2.69	3	8	14	21	9
	Last test.....	2.69	4	9	12	19	13	5	2.48	14	5	11	13
													7
Average number tests, 4.98													
Range of tests, 3-5	First test.....	3.51		2	25	21	4	3.71		3	12	13	24
Average age in days:													
First													
test, 38.78	Average 1 and 2....	3.54		16	31	5	3.60		3	19	17	13	
Last test, 98.03	Average all.....	3.30		8	20	23	1	3.46	1	6	20	15	10
52 F <sub>2</sub> a													
Females	Average 3, 4 and 5	3.15	2	9	18	21	2	3.37	1	5	6	14	14
	Last test.....	2.92	2	8	3	20	13	4	2.96	4	4	7	16
													14

The averages for the females of  $F_2a$  and  $F_3a$  are higher in grade than those of the males in every instance except the averages for the first tests for wildness and savageness in both generations and the average of the first and second tests for savageness in the  $F_3a$ . The modal grades in these two generations range as follows: for males in wildness and savageness respectively;  $F_2a$ , 2-4 and 0-4;  $F_3a$ , 3-4 and 0-5; for the females,  $F_2a$ , 2-4 and 2-4;  $F_3a$ , 3-4 and 3-5.

TABLE 9  
*Summary of Results for First Generation Hybrids,  $F_1$ , of Series B*

	WILDNESS						SAVAGENESS								
	Distribution of mice in grades:						Distribution of mice in grades:								
	Avg.	0	1	2	3	4	5	Avg.	0	1	2	3	4	5	
Average number tests, 4.49															
Range of tests, 2-5	First test.....	3.57	1	1	1	28	50	21	3.96	1	1	33	31	36	
Average age in days:															
First test, 36.76	Average 1 and 2....	3.56		1	2	18	58	23	3.78		4	24	40	34	
Last test, 77.09	Average all.....	3.30			10	44	43	5	3.07		1	28	36	25	12
102 $F_1$ b	(96)														
Males	Average 3, 4 and 5 ..	3.13		1	18	37	33	7	2.53	4	14	27	22	22	7
	Last test.....	3.04		8	18	47	19	10	2.50	18	7	19	32	16	10
Average number tests, 4.77															
Range of tests, 3-5	First test.....	4.02			23	48	28	4.10			2	29	26	42	
Average age in days:															
First test, 37.43	Average 1 and 2....	3.93			11	53	35	3.84			4	21	39	35	
Last test, 72.08	Average all.....	3.73			1	33	56	9	3.30		4	10	46	29	10
99 $F_1$ b															
Females	Average 3, 4 and 5 ..	3.59		4	44	43	11	2.91	5	6	18	36	23	11	
	Last test.....	3.71		4	627	39	23	2.65	15	4	16	28	24	12	

In the three generations of Series B (tables 9, 10 and 11), the females attained higher grades in every instance except the average of the first tests for savageness in  $F_3b$ . The modal grades of the averages of this series likewise indicate that the females are generally more wild and savage than the males.

From the results as shown in table 3 it seems fairly clear that the inheritance of wildness and savageness in mice is Mendelian of the "blending" or multiple factor type. The first section of this table shows that the wildness and savageness of the  $F_1$ 's vary about the intermediate grade 3 with some

TABLE 10  
*Summary of Results for Second Generation Hybrids, F<sub>2</sub>, of Series B*

	WILDNESS						SAVAGENESS								
	Distribution of mice in grades:						Distribution of mice in grades:								
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4	5	
Average number tests, 4.97															
Range of tests, 3-5	First test.....	3.86	2	1	3	27	53	29	4.06	1	2	1	27	33	51
Average age in days:															
First															
test, 41.95	Average 1 and 2....	3.61		3	7	22	54	29	3.95		1	8	16	35	55
Last test, 87.64	Average all.....	3.33		6	9	47	48	5	3.24	1	5	25	33	37	14
115 F <sub>2</sub> b Males	Average 3, 4 and 5 .....	3.12	3	6	18	43	38	7	2.71	5	19	28	29	23	11
	Last test.....	2.93	8	6	18	46	27	10	2.00	33	14	17	32	10	9
Average number tests, 4.93															
Range of tests, 2-5	First test.....	3.93		1	3	35	48	31	4.35		2	26	29	61	
Average age in days:															
First															
test, 39.40	Average 1 and 2....	3.90				21	57	40	4.22		3	11	42	62	
Last test, 86.67	Average all.....	3.68		1	3	39	65	10	3.70		2	15	26	48	27
118 F <sub>2</sub> b Females	(117)	Average 3, 4 and 5 .....	3.53	1	6	47	49	14	3.55	1	11	18	26	35	26
	Last test.....	3.31	1	1	22	44	36	14	2.94	16	6	14	38	18	26

TABLE 11  
*Summary of Results for Third Generation Hybrids, F<sub>3</sub>, of Series B*

	WILDNESS						SAVAGENESS								
	Distribution of mice in grades:						Distribution of mice in grades:								
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4	5	
Average number tests, 4.65															
Range of tests, 2-5	First test.....	3.78				7	14	2	4.65		1	6	16		
Average age in days:															
First															
test, 41.13	Average 1 and 2....	3.57			1	5	14	3	4.00		3	9	11		
Last test, 80.17	Average all.....	3.44			3	12	6	2	3.45		5	6	75		
23 F <sub>3</sub> b Males	(22)	Average 3, 4 and 5 .....	3.34	2	2	8	5	5	3.04	3	7	2	4	6	
	Last test.....	3.08	1	1	5	8	4	4	2.65	4	4	2	1	8	
Average number tests, 4.74															
Range of tests, 2-5	First test .....	4.14				4	15	8	4.55		3	6	18		
Average age in days:															
First															
test, 41.11	Average 1 and 2....	3.77				3	19	5	4.16		1	14	12		
Last															
test, 83.00	Average all.....	3.82				8	18	1	3.90		1	5	14	7	
27 F <sub>3</sub> b Females	(26)	Average 3, 4 and 5 .....	3.85			7	18	1	3.71		2	4	3	14	5
	Last test.....	3.70		1	10	11	5	3.62		2	1	9	8	7	

individuals possessing a grade of wildness and savageness or tameness and non-savageness equal to that of the parental generation. The second section of the table indicates that the degree of wildness and savageness of the F<sub>2</sub>'s varies about the same intermediate grade and that this variability is also in accordance with Mendelian expectation in being greater than that of the F<sub>1</sub>'s. The number of cases studied, however, is scarcely large enough to give sufficient basis for an estimate of the number of factors involved.

*B. Effect of age, frequency and number of tests on the lowering of the grade of wildness and savageness in successive tests*

In table 12 are given the average results of the successive tests of all hybrids of the three generations that received the regular tests, and also the amount of difference in the grades of wildness and savageness in the successive tests.

TABLE 12  
*Summary of Results for Regular Tests of All Hybrid Generations*

NUMBER MICE	NUMBER TEST	AVERAGE GRADE FOR		DIFFERENCE IN GRADE	
		Wildness	Savageness	Wildness	Savageness
868	First	3.87	4.06		
850	Second	3.60	3.56	0.27	0.50
850	Third	3.30	3.10	0.30	0.46
797	Fourth	3.11	2.65	0.19	0.45
645	Fifth	2.95	2.21	0.16	0.44

It is readily seen by this table that there is a fairly gradual lessening in the grades of wildness and savageness from the first test to the last. The greatest amount of decrease in the grade of wildness occurs between the second and third tests. With this exception the amount of decrease is greatest between the first and second tests and gradually diminishes with the successive tests.

In the attempt to determine the cause or causes for this lowering of the grades of wildness and savageness with the repetition of the tests, three different methods were used as follows:

1. Individuals were allowed to remain untested, unnumbered, and without being handled, in the cage in which they were

born, (the parents usually being removed), until they had attained the age at which the fifth test would ordinarily be given. Then the five tests were given in the usual way.

This method was used with 9 individuals of  $F_1a$ , and with 48 individuals of  $F_2a$ . The results are given in tables 13 and

TABLE 13  
*Summary of Results of Tests of Old Mice of First Generation Hybrids  $F_1$ , of Series A*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 4.00													
Range of tests, 4	First test.....	4.44			5	4	4.44			1	3	5	
Average age in days:													
First													
test, 86.55	Average 1 and 2	4.11			6	3	3.61			3	5	1	
Last test, 139.00	Average all.....	3.30		5	4	2.80			2	6	1		
9 (old) $F_1a$													
Males and	Average 3, 4 and 5....	2.61	2	6	1	2.00		1	3	5			
Females	Last test.....	2.44	5	4	2.00		3	3	3				
Average number tests, 4.00													
Range of tests, 4	First test.....	4.66			1	2	4.66			1	2		
Average age in days:													
First													
test, 88.33	Average 1 and 2.....	4.16			2	1	3.83			1	1	1	
Last test, 141.00	Average all.....	3.33		2	1	3.00			1	1	1		
3 (old) $F_1a$													
Males	Average 3, 4 and 5	2.50	1	2		2.16		2	1	2			
	Last test.....	2.33	2	1		1.33							
Average number tests, 4.00													
Range of tests, 4	First test.....	4.33			4	2	4.33			1	2	3	
Average age in days:													
First test, 85.66	Average 1 and 2.....	4.08			4	2	3.50			2	4		
Last test, 138.00	Average all.....	3.37		3	3	2.70			1	5			
6 (old) $F_1a$													
Females	Average 3, 4 and 5....	2.66	1	4	1	1.92		1	2	3			
	Last test.....	2.50	3	3	2.33		1	2	3				

14. A comparison of the first part of table 13 with the first part of table 4 shows that while the older mice average higher in wildness and savageness in the first test (4.44 and 4.44, respectively, to 3.98 and 3.97), they grade lower in the fifth test (2.44 and 2.00 to 2.75 and 2.04). When the results of the males and the females are separated the above statement

remains true with the exception of the grade for savageness of the old F<sub>1</sub>a females which exceeds that of the F<sub>1</sub>a females of ordinary age as shown in table 6. The results of the 48 F<sub>2</sub>a's of table 14 when compared with the second part of table 4 and with table 7 indicate that the greater age has caused a

TABLE 14

*Summary of Results of Tests of Old Mice of Second Generation Hybrids, F<sub>2</sub>, of Series A*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 3.98													
Range of tests, 3-4	First test .....	3.79	1	7	7	19	14	3.68		4	18	15	11
Average age in days:													
First													
test, 85.39	Average 1 and 2....	3.50		6	11	19	12	3.19		3	23	17	5
Last test, 135.41	Average all .....	2.94	1	10	23	14		2.43	3	21	17	7	
48 (old) F <sub>2</sub> a Males	Average 3, 4 and 5 .	2.38	1	3	17	18	9	1.64	4	16	13	11	4
and Females	Last test.....	2.04	3	11	16	17	1	1.35	16	15	4	10	3
Average number tests, 4.00													
Range of tests, 4	First test.....	3.65	1	5	3	10	7	3.65		2	12	5	7
Average age in days:													
First test, 85.19	Average 1 and 2....	3.17		5	8	9	4	3.01		2	16	6	2
Last test, 134.88	Average all.....	2.62	1	10	10	5		2.18	3	15	7	1	
26 (old) F <sub>2</sub> a	Average 3, 4 and 5 .	2.07	1	3	12	6	4	1.34	4	10	7	4	1
Males	Last test.....	1.69	3	9	7	7		1.07	10	10	1	4	1
Average number tests, 3.95													
Range of tests, 3-4	First test.....	3.95		2	4	9	7	3.72		2	6	10	4
Average age in days:													
First													
test, 85.63	Average 1 and 2....	3.88		1	3	10	8	3.41		1	7	11	3
Last test, 136.04	Average all .....	3.33			13	9	2.73		6	10	6		
22 (old) F <sub>2</sub> a	Average 3, 4 and 5 .	2.76		5	12	5	2.04	6	6	6	7	3	
Females	Last test.....	2.45	2	9	10	1	1.68	6	5	3	6	2	

decrease in the grades of wildness and savageness of all the tests.

2. The number of tests was increased to eight, and the grades of the last three tests noted.

The individuals used in this experiment numbered 17, and were of the F<sub>2</sub>a. The results are given in table 15. The

results of the first five tests are essentially the same as those given for the  $F_2$ 's in tables 4 and 7, showing that these 17 individuals were normal. The significance of the table is merely

TABLE 15  
*Summary of Results for Seventeen Individuals of Second Generation Hybrids, Series A  
when the number of Tests is increased to Eight*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 8													
Range of tests, 8													
Average age in days:													
First test, 57.88	First test .....	3.29		3	8	4	2	3.88		1	4	8	4
Fifth test, 121.82	Average 1 and 2.....	3.52		8	6	3	3.38		2	6	7	2	2
Eighth test, 167.82	Average first 5 ..	3.06		1	13	3	2.59		3	5	6	2	1
17 $F_2$ a males and females	Average 3, 4, and 5.....	2.74	2	3	10	2	2.00	2	5	1	7	2	1
	Fifth test.....	2.82	2	5	5	3	2.00	3	3	5	4	1	1
	Average 6, 7, and 8.....	1.64	8	6	2	1	1.30	6	4	3	3	1	
	Eighth test.....	1.47	2	7	3	5	1.00	8	5	4			
Average number tests, 8													
Range of tests, 8													
Average age in days:													
First test, 57.54	First test .....	3.58		1	3	1	2	4.33		1	4	2	
Fifth test, 121.77	Average 1 and 2	3.57		3	3	1	3.47		2	2	3		
Eighth test, 167.77	Average first 5 ..	2.19		1	5	1	1.39		2	3	2		
7 $F_2$ a Males	Average 3, 4 and 5.....	2.30	2	2	3		1.30	2	3	2			
	Fifth test.....	1.85	2	4	1		1.14	3	1	2	1		
	Average 6, 7 and 8.....	1.22	6	1			0.40	6	1				
	Eighth test.....	1.00	2	4	1		0.42	6	1				
Average number tests, 8													
Range of tests, 8													
Average age in days:													
First test, 57.92	First test .....	3.10		2	5	3	3.70		1	3	4	2	
Fifth test, 121.98	Average 1 and 2	3.50		5	3	2	3.60		4	4	2		
Eighth test, 167.97	Average first 5 ..	2.82		8	2		2.60		1	2	4	2	1
10 $F_2$ a females	Average 3, 4 and 5.....	3.06	1	7	2		2.56	2	1	5	2		
	Fifth test.....	3.60	2	4	3	2	2.60	2	3	3	1		
	Average 6, 7 and 8.....	2.13	2	5	2	1	1.96	4	2	3	1		
	Eighth test.....	2.10	3	3	4		1.40	2	5	3			

to show that the decrease in the grades of wildness and savageness continues with the successive tests when the number of tests is increased to eight.

3. Litters were equally divided and the individuals of one group were tested every day or every two days until the five tests were given, while the individuals of the other group were tested at the usual times.

The division of the mice in this experiment depended entirely upon the order in which the mice were caught for their first test. The first mouse was put in the cage of those to be tested at the usual times and the second was put into the cage of those to be tested daily. Hence, each litter was divided into two practically equal groups which, having the same ancestry, should form a basis for a fairly accurate estimate of the effect of frequency of tests upon the lowering of the grades of wildness and savageness.

The first mice to be used in this experiment were the 12 wild mice raised in the laboratory and later used as wild parental stock (table 1). There were two litters of six mice each. One litter had four males and two females and the other two males and four females. They were therefore not divided according to chance, as has just been mentioned but into two groups of three males and three females each. The results of the group with the usual time intervening between the tests (Group 1) are given in table 16, and those receiving daily tests (Group 2) in table 17. In the case of wildness, when the results of the males and females are considered together as are shown in the first part of the tables, the averages are identical with the exception of that for the fifth test which is 0.34 grade greater for the mice tested daily. The averages of the first test for savageness are also the same for both groups, and the remaining compare very favorably, the difference being in no case greater than 0.25 grade. When the results for the males and females are considered separately the females of Group 2 are seen to grade, as a rule, slightly higher than those of Group 1.

The sixth and seventh tests of the mice of Group 2 were given at the same time the mice of Group 1 were receiving their fourth and fifth tests. Assuming that the three factors, namely, age, presence of the experimenter while feeding and testing, and the handling during the tests, each have a certain effect on the lowering of the grades in successive tests; a comparison of the averages of the fourth and the fifth tests of the mice of Group 1 with the averages of the sixth and seventh tests of those of

Group 2 should give the measure of the effect of the two extra tests, since the ages of both groups are the same and hence, the effect of the presence of the experimenter would likewise be equal. In the case of the males this effect seems to be indicated in both wildness and savageness as the average grades for the

TABLE 16  
*Summary of Results of Group 1, Parental Generation, Wild, Tested at Usual Times*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 5													
Range of tests, 5	First test.....	5.0					64.5				1	1	4
Average age in days:													
First test, 37	Average 1 and 2 ....	5.0					64.58				2	4	
Fourth test, 70	Average all.....	4.83					64.23				4	2	
Last test, 88	Average 3, 4 and 5....	4.66					54.0				2	3	1
6 P (Wild)	males and females	4.58					53.83				1	4	1
	Last test.....	4.16		1	3	2	3.0				1	4	1
Average number tests, 5													
Range of tests, 5	First test.....	5.0					34.66				1		2
Average age in days:													
First test, 37	Average 1 and 2 ....	5.0					34.66				1	2	
Fourth test, 70	Average all.....	4.86					34.2				2	1	
Last test, 88	Average 3, 4 and 5....	4.77					23.88				1	1	1
3 P (Wild)	Males	4.66					33.66				1	2	
	Last test.....	4.33		1	1	1	2.66				1	2	
Average number tests, 5													
Range of tests, 5	First test.....	5.0					34.33				1	2	
Average age in days:													
First test, 37	Average 1 and 2 ....	5.0					34.5				1	2	
Fourth test, 70	Average all.....	4.8					34.36				2	1	
Last test, 88	Average 3, 4 and 5....	4.66					24.11				1	2	
3 P (Wild)	females	4.5					24.0				2	2	1
	Last test.....	4.0		2	1	3.33				2	1		

sixth and the seventh tests of Group 2 are, respectively, 0.66 and 0.33 of a grade lower than the averages for the fourth and fifth tests of Group 1. In the case of the females, however, this does not maintain inasmuch as the averages for wildness are identical in each group and the average for savageness in the sixth and seventh tests of Group 2 is 0.5 of a grade higher

than that for the fourth and fifth tests of Group 1. The differences in the grades of these wild individuals are so slight and the number of mice so small that these results cannot be con-

TABLE 17  
*Summary of Results of Group 2, Parental Generation, Wild, Tested Daily*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 7													
Range of tests, 7	First test.....	5.0					64.5			1	1	4	
Average age in days:													
First test, 37	Average 2 and 1 ....	5.0					64.33			2	4		
Fifth test, 41													
Sixth test, 70	Average first 5.....	4.83					154.11			2	1	3	
Seventh test, 88	Average 3, 4 and 5 ..	4.66					154.2			2	2	2	
6 P (Wild) males and females	Fifth test.....	4.5					1144.0			2	2	2	
	Average 6 and 7 ....	4.25					333.91			2	1	3	
Average number tests, 7													
Range of tests, 7	First test.....	5.0					34.0			1	1	1	
Average age in days:													
First test, 37	Average 1 and 2 ....	5.0					33.66			2	1		
Fifth test, 41													
Sixth test, 70	Average first 5.....	4.66					123.86			2	1		
Seventh test, 88	Average 3, 4 and 5 ..	4.44					124.0			1	1	1	
3 P (Wild) Males	Fifth test.....	4.0					114.0			1	1	1	
	Average 6 and 7 ....	4.0					213.33			2	1		
Average number tests, 7													
Range of tests, 7	First test.....	5.0					35.0					3	
Average age in days:													
First test, 37	Average 1 and 2 ....	5.0					35.0					3	
Fifth test, 41													
Sixth test, 70	Average first 5.....	5.0					34.53				1	2	
Seventh test, 88	Average 3, 4 and 5 ..	5.0					34.22			1	1	1	
3 P (Wild) Females	Fifth test.....	5.0					134.0			1	1	1	
	Average 6 and 7 ....	4.5					124.5			1	1	2	

sidered of very great value. The chief significance of tables 16 and 17 is to give an example of the reactions of wild mice to the conditions of the experiment and thus furnish a basis for the more accurate judgment of the hybrids.

Mice from F<sub>1</sub>b were next used in this study. 14 individuals comprised Group 1 and 16 Group 2. The results are given in tables 18 and 19. From F<sub>2</sub>b four groups were used. The mice forming two of these groups were very much younger than those comprising the other two groups of F<sub>2</sub>b and also the two

TABLE 18  
*Summary of Results of Group 1, First Generation Hybrids, F<sub>1</sub>, of Series B, Tested at the Usual Times*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 5													
Range of tests, 5	First test.....	4.14		2	8	4	4.57			1	4	9	
Average age in days:													
First													
test, 52.00	Average 1 and 2 ....	4.35		7	7	4.53				5	9		
Last test, 82.28	Average all.....	4.05		2	10	2	3.94		1	4	6	3	
14 F <sub>1</sub> b males	Average 3, 4 and 5 ..	3.88		4	8	2	3.54		1	1	7	3	2
and females	Last test.....	4.07		1	11	2	3.21		2	2	5	5	2
Average number tests, 5													
Range of tests, 5	First test.....	4.35		1		2	4.33			1		2	
Average age in days:													
First													
test, 36.00	Average 1 and 2 ....	4.66		1		2	4.66			1		2	
Last test, 66	Average all.....	4.26		1	1	1	3.8			1	1	1	
3 F <sub>1</sub> b Males	Average 3, 4 and 5 ..	4.0		1	1	1	3.22		1	1	1		
	Last test.....	4.33		2		1	3.0		1	1	1		
Average number tests, 5													
Range of tests, 5	First test.....	4.09		1	8	2	4.63			4		7	
Average age in days:													
First													
test, 56.36	Average 1 and 2 ....	4.22		6	5	4.50				4		7	
Last test, 86.76	Average all.....	4.0		1	9	1	3.98		1	3	5	2	
11 F <sub>1</sub> b females	Average 3, 4 and 5 ..	3.84		3	7	1	3.63		1	6	2	2	
	Last test.....	4.0		1	9	1	3.27		1	4	4	2	

groups of F<sub>1</sub>b. There were 37 of these younger mice, 19 in Group 1 and 18 in Group 2. The results are presented in tables 20 and 21. Group 1 of the older mice contained 17 individuals, while 19 mice comprised Group 2. The results of the tests of these are given in tables 22 and 23.

TABLE 19  
*Summary of Results of Group 2, First Generation Hybrids, F<sub>1</sub>, of Series B, Tested Daily*

		WILDNESS						SAVAGENESS					
		Distribution of mice in grades:						Distribution of mice in grades:					
		Av.	0	1	2	3	4	5	Av.	0	1	2	3
Average number tests, 5.86													
Range of tests, 4-6	First test.....	4.62			1	4	11	4.62			1	4	11
Average age in days:													
First test, 54.0	Average 1 and 2 ....	4.22			1	7	8	4.35			1	7	8
Fifth test, 58.93	Average first 5.....	4.06			1	13	2	3.87			4	10	2
Sixth test, 86.21	Average 3, 4 and 5 ..	3.98			3	12	1	3.58			4	10	2
16 F <sub>1</sub> b Males and Females	Fifth test.....	3.42			6	6	3	3.06	1		1	8	4
	(15)												
	Sixth test.....	3.78		1	4	6	3	3.78			1	4	6
	(14)												
Average number tests, 5.4													
Range of tests, 4-6	First test.....	4.8			1	4	4	4			3	2	
Average age in days:													
First test, 43.4	Average 1 and 2 ....	4.2			2	3	3	8			1	4	
Fifth test, 48.2	Average first 5.....	3.8			1	4	3	6			2	3	
Sixth test, 76.66	Average 3, 4 and 5 ..	3.57			2	3	3	07			2	3	
5 F <sub>1</sub> b Males	Fifth test.....	3.0			4		2	0	1		1	2	
	(4)												
	Sixth test.....	4.0		1	1	1	4	0			1	1	1
	(3)												
Average number tests, 6													
Range of tests, 6	First test.....	4.54			1	3	7	4.72			1	1	9
Average age in days:													
First test, 58.81	Average 1 and 2 ....	4.22			1	5	5	4.59			3	8	
Fifth test, 63.81	Average first 5 .....	4.14			9	2	4	07			2	7	2
Sixth test, 88.81	Average 3, 4 and 5 ..	4.09			1	9	1	3.72			2	7	2
11 F <sub>1</sub> b Females	Fifth test.....	4.09			2	6	3	3.54			6	4	1
	Sixth test.....	3.72		1	3	5	2	3.72			1	3	5

The sixth test of Group 2 of each set was given at the same time the mice of the corresponding Group 1 received their fifth test. It is to be noted that while the average grade for

the sixth test is greater in each case than that for the fifth test of the same group, (First section of tables 19, 21, and 23), due, without doubt, to the absence of any handling by the experimenter during the 27 or 28 days intervening since the fifth test, yet only in the case of the younger mice of  $F_2b$  is the aver-

TABLE 20  
*Summary of Results of Group 1, Second Generation Hybrids,  $F_2$ , of Series B, Tested at Usual Times*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 4.89													
Range of tests, 3-5	First test.....	4.0	1		2	10	6	3.94	1	1	3	5	9
Average age in days:													
First test, 34.52	Average 1 and 2 .....	3.89	1	1	8	9	4.18	1	2	5	12		
Last test, 65.15	Average all.....	3.18	2	7	9	13.18	1	1	2	4	11		
19 $F_2b$ Males and Females	Average 3, 4 and 5 .....	2.69	1	1	2	8	6	12.49	1	3	3	4	7
	Last test.....	2.42	2	1	4	6	5	11.78	6	1	8	3	1
Average number tests, 5													
Range of tests, 5	First test.....	3.7	1		1	5	23.8	1	1	3	4		
Average age in days:													
First test, 34.4	Average 1 and 2 .....	3.45	1	1	4	3	3.9	1	1	2	5		
Last test, 66.3	Average all.....	2.98	2	4	3	3.12	1	1	1	1	5		
9 $F_2b$ Males	Average 3, 4 and 5 .....	2.66	1	1	3	3	2.6	1	2	1	4		
	Last test.....	2.4	2	2	3	2	2.3	3	1	3	2		
Average number tests, 4.77													
Range of tests, 3-5	First test.....	4.33			1	5	44.11			3	2	5	
Average age in days:													
First test, 34.64	Average 1 and 2 .....	4.37			4	6	4.5			3	7		
Last test, 62.22	Average all.....	3.41			3	6	13.25			1	3	6	
10 $F_2b$ Females	Average 3, 4 and 5 .....	2.72		1	5	3	12.36	1	2	3	3	1	
	Last test.....	2.44	1	2	3	3	11.22	3		5	1	1	

age grade for wildness in the sixth test of Group 2 greater than that for wildness in the fifth test of the corresponding Group 1 (table 20). The average grade for savageness for the sixth tests of each Group 2 is greater than that for the fifth test of the corresponding Group 1.

The explanation for the fact that the sixth test for wildness of the older mice in the second groups did not follow that of the younger mice in being higher in grade than the fifth test of the corresponding first groups may be found in the difference observed in the general type of reaction to handling as the

TABLE 21  
*Summary of Results of Group 2, Second Generation Hybrids, F<sub>2</sub>, of Series B, Tested Daily*

	WILDNESS						SAVAGENESS					
	Av.	Distribution of mice in grades:					Av.	Distribution of mice in grades:				
		0	1	2	3	4		0	1	2	3	4
Average number tests, 5.94												
Range of tests, 5-6	First test.....	4.05			5	7	6	4.44			3	4
Average age in days:											11	
First test, 35.11	Average 1 and 2 ..	3.66			5	9	4	4.05			4	6
Fifth test, 39.88											8	
Sixth test, 66.64	Average first 5....	3.45		2	9	6	1	3.52	1	1	6	7
18 F <sub>2</sub> b Males and Females	Average 3, 4 and 5.....	3.31		1	9	8	3	3.16	1	3	6	4
	Fifth test.....	3.05		3	11	4	2	2.77	2	2	1	8
	Sixth test.....	3.35		1	9	7	3	3.82	1	1	5	3
Average number tests, 5.88											7	
Range of tests, 5-6	First test.....	4.11			1	6	2	4.44			2	1
Average age in days:											6	
First test, 35.33	Average 1 and 2 ..	3.33			4	5	3	3.83			4	1
Fifth test, 40.33											4	
Sixth test, 66.00	Average first 5....	3.06		2	6	1	3	3.2	1	1	3	4
9 F <sub>2</sub> b Males	Average 3, 4 and 5.....	2.88		1	7	1	2	2.77	1	2	3	3
	Fifth test.....	2.77		2	7		2	2.22	2	1	5	1
	Sixth test.....	3.12		1	5	2	3	3.0	1	1	4	1
Average number tests, 6											1	1
Range of tests, 6	First test.....	4.0			4	1	4	4.48			3	5
Average age in days:												
First test, 34.88	Average 1 and 2 ..	4.0			1	4	4	4.27			5	4
Fifth test, 39.44												
Sixth test, 67.22	Average first 5....	3.84		3	5	1	3	3.84			3	3
9 F <sub>2</sub> b Females	Average 3, 4 and 5.....	3.74		2	7		3	3.55	1	3	1	4
	Fifth test.....	3.33		1	4	4	3	3.33	1	1	3	2
	Sixth test.....	3.55		4	5		4	4.55			1	2

hybrids grew older. There seemed to be a lesser tendency to violent reactions of either wildness or savageness with a somewhat more aggressiveness in the latter. With age they became, as it were, more deliberate in their movements.

In order to compare more easily the results included in tables 18 to 23 inclusive, the more important points of these

have been brought together in table 24. The headings at the top show the different hybrid generations and the groups. The headings at the side indicate (a) the table in which the complete results of a group may be found, (b) the number of mice in each groups, (c) the average age in days of the group at the first test, the fifth test, and the difference between these

TABLE 22  
*Summary of Results of Group 1, Second Generation Hybrids, F<sub>2</sub>, of Series B, Tested at Usual Times*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 5													
Range of tests, 5	First test.....	4.0			6	5	6	4.05			6	4	7
Average age in days:													
First test, 59.82	Average 1 and 2...	4.14			1	7	9	4.35			8	9	
Last test, 91.35	Average all .....	3.84			5	10	2	3.49			3	4	7
17 F <sub>2</sub> b Males and Females	Average 3, 4 and 5.....	3.64			8	9	2	2.92	2	4	7	2	2
	Last test.....	3.64		2	4	9	2	2.58	3	1	3	6	1
Average number tests, 5													
Range of tests, 5	First test.....	4.0			3	1	3	4.0			3	1	3
Average age in days:													
First test, 59.57	Average 1 and 2...	4.14			1	4	2	4.42			3	4	
Last test, 91.14	Average all .....	3.85			2	3	2	3.42			3	4	
7 F <sub>2</sub> b Males	Average 3, 4 and 5.....	3.66		1	6	2	7.6	1	2	3	1		
	Last test.....	3.57		1	2	3	1	1.85	2	1	1	2	1
Average number tests, 5													
Range of tests, 5	First test.....	4.0			3	4	3	4.1			3	3	4
Average age in days:													
First test, 60.0	Average 1 and 2...	4.15			3	7	4	3			5	5	
Last test 91.5	Average all .....	3.84			3	7	3	3.6			3	1	3
10 F <sub>2</sub> b Females	Average 3, 4 and 5.....	3.63		1	7	3	3	3.13	1	2	4	1	2
	Last test .....	3.7		1	2	6	1	3.1	1	2	4		3

ages, or in other words, the number of days required for the tests in each group, (d) the average grade of wildness for the first test, for the fifth test, the difference between the first and fifth, the average of the first and second tests for wildness, the average for wildness as shown by the third, fourth, and fifth tests, and the difference between these two averages. Imme-

diately below this, the results for savageness are treated in a like manner. Following this are given, (f) the difference between the number of days required for the tests in Group 1 and in Group 2, (g) the difference in decrease in the average grade of wildness of Group 1 and Group 2 as shown by the difference

TABLE 23  
*Summary of Results of Group 2, Second Generation Hybrids, F<sub>2</sub>, of Series B, Tested Daily*

		WILDNESS						SAVAGENESS					
		Distribution of mice in grades:						Distribution of mice in grades:					
		Av.	0	1	2	3	4	5	Av.	0	1	2	3
Average number tests, 6													
Range of tests, 6	First test.....	4.52		1	7	11	4.26			1	3	5	10
Average age in days:													
First test, 59.42	Average 1 and 2 ..	4.18		2	8	9	4.15			3	4	12	
Fifth test, 64.42													
Sixth test, 91.0	Average first 5....	3.89		2	2	11	4.3.46		2	1	7	4	5
19 F <sub>2</sub> b Males and Females	Average 3, 4 and 5.....	3.7		2	6	7	4.2.94	1	1	6	5	2	4
	Fifth test.....	3.31	1	4	6	4	4.2.68	4	3	6	3	3	3
	Sixth test.....	3.63	1	9	3	6	3.47	2	2	4	5	6	
Average number tests, 6													
Range of tests, 6	First test.....	4.7		3	7	4.5				1	3	6	
Average age in days:													
First test, 59.3	Average 1 and 2 ..	4.05		1	4	5	4.05			3	1	6	
Fifth test, 64.3													
Sixth test, 90.9	Average first 5....	3.76		1	2	5	2.3.4		1	1	3	3	2
10 F <sub>2</sub> b Males	Average 3, 4 and 5.....	3.53		1	6	2	1.2.93		1	2	5	1	1
	Fifth test.....	3.3		3	3	2	2.3.1	1	1	4	2	2	
	Sixth test.....	3.6		6	2	2.3.4	1	2	1	3	3		
Average number tests, 6													
Range of tests, 6	First test.....	4.33		1	4	4	4.0			1	2	2	4
Average age in days:													
First test, 59.55	Average 1 and 2 ..	4.27		1	4	4	4.22				3	6	
Fifth test, 64.55													
Sixth test, 91.11	Average first 5....	4.04		1	6	2	3.46		1	4	1	3	
9 F <sub>2</sub> b Females	Average 3, 4 and 5.....	3.88		1	5	3	2.96	1	4	1	3		
	Fifth test.....	3.33	1	1	3	2	2.2.22	3	2	2	1	1	
	Sixth test.....	3.66	1	3	1	4	3.55	1	3	2	2	3	

in the average grades of tests one and two and of tests three, four and five, (h) the rate of decrease per day as obtained by dividing the fraction of a grade found in (g) by the number of days obtained in (f). Following this in (i) the same values are found for savageness.

The decrease in both wildness and savageness for hybrids F<sub>1</sub>b (tables 18 and 19) compares very favorably with the older mice of F<sub>2</sub>b (tables 22 and 23), except that the latter show a

TABLE 24  
*General Summary of Tables 18, 19, 20, 21, 22, and 23*

	1 HYBRIDS F <sub>1</sub> b		2 HYBRIDS F <sub>2</sub> b		3 HYBRIDS F <sub>2</sub> b	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Table.....	18	19	20	21	22	23
Number of mice.....	14	16	19	18	17	19
Average age in days:						
Fifth test.....	82.28	58.93	65.15	39.88	91.35	64.42
First test.....	52.00	54.00	34.52	35.11	59.82	59.42
Difference.....	30.28	4.93	30.63	4.77	31.53	5.0
Wildness, average grade:						
First test.....	4.14	4.62	4.0	4.05	4.0	4.52
Fifth test.....	4.07	3.42	2.42	3.05	3.64	3.31
Difference.....	0.07	1.20	1.58	1.0	0.36	1.21
Tests 1 and 2.....	4.35	4.22	3.89	3.66	4.14	4.18
Tests 3, 4 and 5.....	3.88	3.93	2.69	3.31	3.64	3.7
Difference.....	0.47	0.29	1.20	0.35	0.50	0.48
Savageness, average grade:						
First test.....	4.57	4.62	3.94	4.44	4.05	4.26
Fifth test.....	3.21	3.06	1.78	2.77	2.58	2.68
Difference.....	1.36	1.56	2.16	1.67	1.47	1.58
Tests 1 and 2.....	4.53	4.35	4.18	4.05	4.35	4.15
Tests 3, 4 and 5.....	3.54	3.53	2.49	3.16	2.92	2.94
Difference.....	0.99	0.82	1.69	0.89	1.43	1.21
Difference in number days required for tests in Group 1 and Group 2.....		25.35		25.86		26.53
Difference in decrease in average grade of Group 1 and Group 2, as shown by tests 1 and 2, and 3, 4, and 5:						
Wildness.....	0.18		0.85		0.02	
Rate of decrease per day	0.0071		0.0328		0.00075	
Savageness.....	0.17		0.80		0.22	
Rate of decrease per day	0.0067		0.0309		0.00829	

slightly greater decrease than the former. Between these two, however, and the younger mice of F<sub>2</sub>b (tables 20 and 21) there is a striking difference. Considering the difference between the first and last tests for wildness and savageness in

each of the three sets of groups (numbered for sake of convenience, 1, 2, and 3), it is to be noted that this difference in Group 2 of the first and third set is greater than the difference in the corresponding Group 1, while in the second set the reverse is true. In other words, with the older mice, whether they are from  $F_1b$  or  $F_2b$ , the decrease in grade of wildness and savageness is greater when the mice are tested every day than when they are tested at intervals of six or eight days, but with the younger mice the daily testing shows the lesser decrease.

When, however, the decreases are considered from the differences of the averages of tests one and of tests three, four and five, the results are uniform in all three sets of groups, that is, the results in the first and third set are reversed and in each set the tests given at intervals of 6 or 8 days show a greater decrease in the grades of wildness and savageness than in the case of the daily testing. It is the opinion of the writer that the difference between the average of the first and second tests and the third, fourth and fifth tests forms the more accurate basis for the judgment of the rate of lowering of the grades of wildness and savageness, since the effect of an error in testing is thus minimized.

Assuming that a test has an equal effect in lowering the grade of wildness or savageness of the mice in Group 1 and Group 2, from the results in table 24 it is possible to obtain an approximate estimate of the effect of age plus the effect of the presence of the experimenter in the room while feeding, cleaning cages and testing other mice. For instance, in the case of Group 1,  $F_1b$ , 0.47 grade represents the lessening of wildness due to the effect of five testings, plus 30.28 days of age and the presence of the experimenter during that time. From Group 2,  $F_1b$ , it is observed that 0.29 grade represents the lessening of wildness due to the effect of five testings, plus 4.93 days of age and the effect of the presence of the experimenter. Subtracting the results of Group 2 from those of Group 1, there is a remainder of 0.18 grade which represents the lessening of the wildness due to the effects of 25.35 days of age and the presence of the experimenter during that time. In the same way the lessening in savageness for the same reasons is found to be 0.85 grade. By dividing the amount of decrease by the number of days are obtained the rates of decrease per day which in

this case are 0.0071 grade for wildness and 0.0067 grade for savageness. These represent the grade-lowering effect of age and the presence of the experimenter exerted each day on the mice of  $F_1b$  when they receive their first test at the average age of 53 days. Likewise the rates per day for wildness and savageness of the younger mice of  $F_b$  are, respectively, 0.0328 grade and 0.0309 grade, and for the older mice of  $F_2b$ , 0.00075 grade and 0.00829 grade. It would thus seem that age and the presence of the experimenter have an effect in lessening the grade of wildness and savageness of the mice inversely in proportion to the age of the mouse, providing the first test is given when the mice are between 33 and 60 days old. The rates according to sex are as follows:

	WILDNESS RATE OF DECREASE PER DAY	SAVAGENESS RATE OF DECREASE PER DAY
$F_1b$		
Males.....	0.00833	0.0281
Females.....	0.00976	0.0000
$F_2b$ (Young)		
Males.....	0.0126	0.00892
Females.....	0.0603	0.0616
$F_2b$ (Old)		
Males.....	0.00225	0.0203
Females.....	0.0049	-0.00339

From these results it is seen that the females had a higher rate of decrease per day for both wildness and savageness except in savageness of the  $F_1b$  and the  $F_2b$  (Old), in which cases it was zero for the former and a negative quantity (0.00339) for the latter.

### *C. Results from crossing wild females with tame males in comparison with the results from crosses of tame females with wild males*

The hybrids used by Professor Yerkes in his study were all obtained by crossing tame female rats with wild male rats. It was to neutralize the effect due to the possibility of the parent of one sex exerting a stronger hereditary and environmental influence on the offspring than the parent of the opposite sex that the first generation hybrids of both series of this study were obtained about equally from wild females crossed with tame

males and from tame females crossed with wild males. For the same reason both parents were allowed to remain, with few exceptions, in the cage with the young until they were weaned. It is proposed, in this section of the paper, to present for closer consideration groups of hybrid individuals of the

TABLE 25

*Summary of Results of First Generation Hybrids, F<sub>1</sub>, of Series A, from Matings of Parental Generation, Tame Female with Wild Male*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 4.06													
Range of tests, 3-5	First test.....	4.02			11	22	12	4.04			11	21	13
Average age in days:													
First test, 43.14	Average 1 and 2....	3.61			2	11	23	9	3.55		18	18	9
Last test, 63.0	Average all.....	3.15			4	29	12	2.79		15	20	8	2
45 F <sub>1</sub> Males and Females	Average 3, 4 and 5.....	2.70			17	24	3	12.06		9	19	15	2
	Last test.....	2.44			3	21	19	1.75	4	17	10	14	
Average number tests, 4.17													
Range of tests, 3-5	First test	3.88			6	7	4	4.0			5	7	5
Average age in days:													
First test, 32.11	Average 1 and 2....	3.47			8	6	3	3.61			8	4	5
Last test, 56.2	Average all.....	2.87			3	13	1	2.80		5	7	3	2
17 F <sub>1</sub> Males	Average 3, 4 and 5.....	2.32			10	7	2.05		2	4	6	6	1
	Last test.....	2.29			2	8	7	1.2	2	8	3	4	
Average number tests 4.0													
Range of tests, 3-5	First test.....	4.10			5	15	8	4.07			6	14	8
Average age in days:													
First test, 49.85	Average 1 and 2....	3.69			2	3	17	6	3.51		10	14	4
Last test, 67.25	Average all.....	3.33			1	16	11	2.79		10	13	5	
28 F <sub>1</sub> Females	Average 3, 4 and 5.....	2.96			7	17	3	12.07		5	13	9	1
	Last test.....	2.53			1	13	12	1.25	2	9	7	10	

first, second and third generations obtained from a cross of wild females with tame males and other groups obtained from a cross of tame females with wild males. In most cases the individuals of the F<sub>2</sub> were offspring of the F<sub>1</sub> mice represented in the tables, likewise most of the F<sub>3</sub> mice were obtained from matings of the F<sub>2</sub>.

The results of tests of the group of first generation hybrids of Series A from matings of tame females with wild males are presented in table 25, and from matings of wild females with tame males in table 26, while those of Series B are to be found in tables 27 and 28, respectively. In the same order the results from the second generation hybrids are given in tables 29,

TABLE 26  
*Summary of Results of First Generation Hybrids, F<sub>1</sub>, of Series A, from Matings of Parental Generation, Wild Female with Tame Male*

	WILDNESS							SAVAGENESS							
	Distribution of mice in grades:							Distribution of mice in grades:							
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4	5	
Average number tests, 4.52															
Range of tests, 4-5	First test.....	4.0		1	1	10	23	15	4.0		1		11	23	15
Average age in days:															
First test, 35.84	Average 1 and 2...	3.91			1	6	29	14	3.63				9	36	5
Last test, 62.38	Average all.....	3.36			1	21	26	2	2.96			10	26	13	1
50 F <sub>1</sub> a Males and Females	Average 3, 4 and 5.....	2.93			4	29	15	2	2.42		4	15	21	8	2
	Last test.....	3.02		1	12	24	11	2	2.07	4	11	11	17	6	1
Average number tests, 4.52															
Range of tests, 4-5	First test.....	4.08		1		4	9	9	3.65	1			8	10	4
Average age in days:															
First test, 31.53	Average 1 and 2...	4.04			1	2	17	3	3.34				7	15	1
Last test, 62.16	Average all.....	3.48				7	14	2	2.81		6	12	5		
23 F <sub>1</sub> a Males	Average 3, 4 and 5.....	3.03		3	9	10	1	2.39		1	9	8	5		
	Last test.....	3.17		4	12	6	1	2.25	2	5	5	7	4		
Average number tests, 4.51															
Range of tests, 4-5	First test.....	3.92			1	6	14	6	4.29				3	13	11
Average age in days:															
First test, 34.44	Average 1 and 2...	3.79				4	12	11	3.87				2	21	4
Last test, 62.57	Average all.....	3.27		1	14	12		3.08			4	14	8	1	
27 F <sub>1</sub> a Females	Average 3, 4 and 5.....	2.85		1	20	5	1	2.45		3	6	13	3	2	
	Last test.....	2.88		1	8	12	5	1	1.92	2	6	6	10	2	1

30, 31, and 32; and those from the third generation hybrids in tables 33, 34, 35, and 36.

The differences in the results of the tests of these mice are so slight that no attempt will be made to discuss each table separately. The essential points from all the tables have been brought together and are presented in table 37. In the first

column of this table will be found the average grade for all the tests and the average grade for the third, fourth, and fifth tests for wildness and savageness of the first, second, and third generation hybrids of Series A from the matings of tame females with wild males. In the second column are given the

TABLE 27

*Summary of Results of First Generation Hybrids, F<sub>1</sub>, of Series B, from Matings of Parental Generation, Tame Female with Wild Male*

	WILDNESS							SAVAGENESS						
	Distribution of mice in grades:							Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4	5
Average number tests, 5														
Range of tests, 5	First test.....	4.43			3	11	16	4.2				9	5	16
Average age in days:														
First test, 36.26	Average 1 and 2...	4.13			3	10	17	4.01				5	12	13
Last test, 73.26	Average all .....	3.54			2	10	17	12.8			1	7	13	9
30 F <sub>1b</sub> Males and Females	Average 3, 4 and 5.....	3.14			7	12	11	2.21	3	6	8	8	5	1
	Last test.....	3.0		3	4	15	6	21.96	8	4	4	10	3	1
Average number tests, 5														
Range of tests, 5	First test.....	4.33			2	4		3.66				4		2
Average age in days:														
First test, 37	Average 1 and 2	3.91			2	3	1	3.58				3	1	2
Last test, 73.0	Average all .....	3.13			2	3	1	2.33		1	3		2	
6 F <sub>1b</sub> Males	Average 3, 4 and 5.....	2.61			3	2	1	1.50	2	1	1	2		
	Last test.....	3.0		2	2	2		1.66	2	1	1	1	1	1
Average number tests, 5														
Range of tests, 5	First test.....	4.86			1	7	16	4.72				5	5	14
Average age in days:														
First test, 39.36	Average 1 and 2...	4.18			1	7	16	4.12				2	11	11
Last test 80.0	Average all .....	3.64			7	16	13.08				4	13	7	
24 F <sub>1a</sub> females	Average 3, 4 and 5.....	3.25			4	10	10	2.38	1	5	7	6	5	1
	Last test.....	3.27		3	2	13	4	22.22	6	3	3	9	2	1

sexes which attained the higher average grade in these tests. In the third and fourth columns are presented the like values for Series B of the same matings, while in the fifth and sixth, and the seventh and eighth columns are given these values for Series A and Series B, respectively, from matings of wild females with tame males.

From this table it is readily seen that the mice of Series A, tame female by wild male, became generally less wild and less savage in succeeding generations according to the averages of all the tests and the averages of the third, fourth, and fifth tests, the only exception being the average of all the tests for savageness of the  $F_2$  hybrids, which grade is greater than the

TABLE 28  
*Summary of Results of First Generation Hybrids,  $F_1$ , of Series B, from Matings of Parental Generation, Wild Female with Tame Male*

	WILDNESS							SAVAGENESS						
	Distribution of mice in grades:							Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4	5
Average number tests, 4.65														
Range of tests, 4-5	First test.....	3.76	1	10	8	7	4.07		1	7	7	11		
Average age in days:														
First test, 39.76	Average 1 and 2...	3.61	1	1	6	11	73.94		1	4	11	10		
Last test, 104.52	Average all.....	3.35		5	9	9	33.25		7	6	10	3		
26 $F_{1b}$ Males and Females	Average 3, 4 and 5.....	3.16	1	6	10	6	32.73	1	3	6	6	8	2	
	Last test.....	3.22	2	4	10	6	42.47	5	1	6	9	4	1	
Average number tests, 4.53														
Range of tests, 4-5	First test.....	3.71	1	7	4	5	3.88		1	6	4	6		
Average age in days:														
First test, 37.70	Average 1 and 2...	3.14	1	1	6	4	53.73		1	4	7	5		
Last test, 101.88	Average all.....	2.93		5	5	5	22.93		7	4	4	2		
17 $F_{1b}$ Males	Average 3, 4 and 5.....	2.74	1	6	6	3	12.3	1	3	5	3	4	1	
	Last test.....	2.76	2	3	9	3	1.44	5	1	4	6	1		
Average number tests, 4.88														
Range of tests, 4-5	First test.....	3.88		3	4	2	4.44		1	3	5			
Average age in days:														
First test, 32.77	Average 1 and 2...	4.44			7	24.33						4	5	
Last test, 107.48	Average all.....	4.09			4	4	13.81					2	6	1
9 $F_{1b}$ Females	Average 3, 4 and 5.....	3.84		4	3	2	3.46		1	3	4	1		
	Last test.....	4.11		1	1	3	43.62		2	3	3	1		

like average of the  $F_1$  or the  $F_2$ . The females of this series were, as a rule, more savage than the males, and were also more wild in the first and second generations, the males grading higher in wildness in the third generation.

The results of the crosses of Series B, tame female by wild male, are directly opposed to those of Series A, the mice in this

case attaining, without exception, increasingly higher average grades of wildness and savageness in the successive generations. In this series, again, the females grade higher in wildness and savageness in the first two generations while the males of the third generation were both more wild and more savage than the females.

TABLE 29

*Summary of Results of Second Generation Hybrids, F<sub>2</sub>, of Series A, from Matings of Parental Generation, Tame Female with Wild Male*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 4.39													
Range of tests, 3-5	First test.....	3.51	1	3	16	16	5	4.12		1	6	21	13
Average age in days:													
First test, 47.78	Average 1 and 2...	3.35		2	17	19	3	3.47		1	5	8	20
Last test, 115.22	Average all .....	2.92		11	22	7	1	3.21		4	15	13	8
41 F <sub>2</sub> a Males and Females	Average 3, 5 and 5.....	2.57	2	6	16	14	4	1.96	5	10	10	13	3
	Last test.....	2.48	2	6	15	8	8	21.38	10	7	9	10	4
Average number tests, 4.35													
Range of tests, 4-5	First test.....	3.35	1	2	8	7	2	4.2		2	12	6	
Average age in days:													
First test, 50.30	Average 1 and 2...	3.17		1	11	8	3	3.4		4	5	8	3
Last test, 107.25	Average all.....	2.73		8	9	3	2	3.39		3	8	6	3
20 F <sub>2</sub> a Males	Average 3, 4 and 5.....	2.36	2	2	9	5	4	1.53	4	5	3	8	1
	Last test.....	2.2	2	3	9	1	5	1.14	6	5	3	5	1
Average number tests, 4.42													
Range of tests, 3-5	First test.....	3.66		1	8	9	3	4.04		1	4	9	7
Average age in days:													
First test, 45.38	Average 1 and 2...	3.52		1	6	11	3	3.54		1	1	3	12
Last test, 120.45.....	Average all.....	3.10		3	13	4	1	3.97		1	7	7	5
21 F <sub>2</sub> a Females	Average 3, 4 and 5.....	2.76	4	7	9	1	2	3.37	1	5	7	5	3
	Last test.....	2.76	3	6	7	3	2	2.45	4	2	6	5	1

The results of both Series A and Series B of the hybrids, wild female by tame male, seem to show, as a rule, that the grades attained in wildness and savageness in the first generation are lowered in the second generation and then, in the third, raised to somewhat near that attained in the first. The exceptions to this rule are the averages for all the tests for

wildness in Series A, which show a decrease in wildness in the successive generations, and the averages of the third, fourth and fifth tests for savageness in Series B, which indicate a slight increase in savageness in each succeeding generation.

The grades in wildness and savageness attained by the females of Series B are generally in excess of those attained by

TABLE 30

*Summary of Results of Second Generation Hybrids, F<sub>2</sub>, of Series A, from Matings of Parental Generation, Wild Female with Tame Male*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 4.10													
Range of tests, 3-5	First test.....	3.96			8	24	7	3.97	1		5	16	17
Average age in days:													
First test, 38.07	Average 1 and 2..	3.84			7	22	10	3.52	1		2	6	20
Last test, 104.2	Average all .....	3.1			5	22	11	12.76	1	3	8	14	12
39 F <sub>2</sub> a Males	Average 3, 4 and												
and Females	5.....	2.4		5	14	14	5	12.04	2	8	12	12	4
	Last test .....	2.43	2	6	11	14	5	10.86	7	10	9	9	3
Average number tests, 4.30													
Range of tests, 4-5	First test.....	4.0			3	7	3	4.23			2	6	5
Average age in days:													
First test, 31.53	Average 1 and 2..	3.8			3	7	3	3.76			1	3	4
Last test, 97.0	Average all .....	2.92			3	5	4	12.83			1	2	4
13 F <sub>2</sub> a	Average 3, 4 and												
Males	5.....	2.16	2	4	3	2	3	12.03	1	2	3	5	1
	Last test .....	2.46	2	2	2	3	3	11.25	2	2	3	5	1
Average number tests, 4.													
Range of tests, 3-5	First test.....	3.96			5	17	4	3.84	1		3	10	12
Average age in days:													
First test, 41.34	Average 1 and 2..	3.86			4	15	7	3.4	1		1	3	16
Last test, 100.68	Average all .....	3.2			2	17	7	2.73	1	2	6	10	7
26 F <sub>2</sub> a	Average 3, 4 and												
Females	5.....	2.53		1	11	12	2	2.05	1	6	9	7	3
	Last test .....	2.42		4	9	11	2	0.72	5	8	6	4	3

the males. In Series A, however, the males graded higher in wildness in the first generation and higher in savageness in the third generation. In the case of the averages for savageness of F<sub>1</sub>, Series A, tame female by wild male, and of F<sub>2</sub>, Series B, tame female by wild male, and also in the case of the averages for wildness of F<sub>3</sub>, Series B, wild female by tame male, the males

attained the higher grades, according to the averages of all the grades, and the females, when the averages of the last three tests are considered, however, the females are assumed to be the more savage or wild, as the case may be, since the height of the grades of the females, though not so great in the first two tests as that of the males, was more nearly maintained throughout the five tests.

TABLE 31

*Summary of Results of Second Generation Hybrids, F<sub>2</sub>, of Series B, from Matings of Parental Generation, Tame Female with Wild Male*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 4.97													
Range of tests, 4-5	First test.....	4.21			16	20	30	4.63	1		3	14	48
Average age in days:													
First test, 38.01	Average 1 and 2 ..	3.99		1	10	27	28	4.42	1	1	21	43	
Last test, 85.82	Average all .....	3.72	2	1	16	39	83.90		2	2	11	32	19
66 F <sub>1</sub> b Males and Females	Average 3, 4 and 5.....	3.54	2	1	4	13	38	83.55	1	3	7	14	24
	Last test.....	3.31	2	2	8	26	17	112.96	8	2	6	28	1111
Average number tests, 5													
Range of tests, 5	First test.....	4.2			8	10	12	4.63	1	1	5	23	
Average age in days:													
First test, 38.36	Average 1 and 2 ..	3.86		1	7	11	11	4.43	1	1	7	21	
Last test, 88.36	Average all .....	3.64	1	1	9	13	63.79		1	1	7	12	9
30 F <sub>2</sub> b Males	Average 3, 4 and 5.....	3.48	1	1	2	7	16	33.36	2	6	8	8	6
	Last test.....	3.33	1	1	3	13	6	62.7	6	1	2	13	54
Average number tests, 4.91													
Range of tests, 4-5	First test.....	4.22			8	10	18	4.63		2	9	25	
Average age in days:													
First test, 37.72	Average 1 and 2 ..	4.09			3	16	17	4.98			14	22	
Last test, 83.58	Average all .....	3.79	1		7	26	23.99		1	1	4	20	10
36 F <sub>2</sub> b Females	Average 3, 4 and 5.....	3.59	1	2	6	22	53.69	1	1	1	6	16	11
	Last test.....	3.30	1	1	5	13	11	53.2	2	1	4	16	67

#### D. General summary of individual inheritance and the results of selective breeding in the hybrid generations of both series

In this section of the study the attempt is made to indicate the differences in the inheritance of individual mice rather than

that of groups of mice as in the preceding sections. The results of the inheritance of the offspring from selected matings are included in the results of the general matings in order to give better opportunity for comparison than could otherwise be obtained.

TABLE 32

*Summary of Results of Second Generation Hybrids, F<sub>2</sub>, of Series B, from Matings of Parental Generation, Wild Female with Tame Male*

	WILDNESS						SAVAGENESS							
	Distribution of mice in grades:						Distribution of mice in grades:							
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4	5
Average number tests, 5														
Range of tests, 5	First test.....	3.28	1	2	2	5	14	1	3.36	1	2	7	6	9
Average age in days:														
First test, 39.96	Average 1 and 2..	3.4		1	1	7	11	5	3.84	1	1	7	6	11
Last test, 80.23	Average all .....	2.92		2	4	12	7	3.2	1	1	5	7	8	3
25 F <sub>2</sub> b Males and Females	Average 3, 4 and 5.....	2.6	1	1	9	10	3	1	2.77	2	3	5	6	3
	Last test .....	2.28	2	3	10	6	4	2.04	6	2	4	9	3	1
Average number tests, 5														
Range of tests, 5	First test.....	3.3	1	1	1	1	8	1	3.84	1	1	2	3	6
Average age in days:														
First test, 38.61	Average 1 and 2..	3.21		1	1	2	7	2	3.8	1	1	5	1	6
Last test, 77.15	Average all .....	2.66		2	2	7	2	2.95	1	1	3	2	6	
13 F <sub>2</sub> b Males	Average 3, 4 and 5.....	2.3	1	1	5	5	1	2.38	2	2	3	2	4	
	Last test.....	1.76	2	3	4	4		1.46	5	2	1	5		
Average number tests, 5														
Range of tests, 5	First test.....	3.25		1	1	4	6	3.66		1	5	3	3	
Average age in days:														
First test, 41.41	Average 1 and 2..	3.62			5	4	3	3.87			2	5	5	
Last test, 87.91	Average all .....	3.2			2	5	5	3.46			2	5	2	3
12 F <sub>2</sub> b Females	Average 3, 4 and 5.....	2.91			4	5	2	1	3.19	1	2	4	2	3
	Last test.....	2.83			6	2	4	2.66	1	3	4	3	1	

To show to best advantage the individual inheritance, the results of the averages of the third, fourth, and fifth tests have been arbitrarily chosen as the criteria and the six grades, 0 to 5, have been divided into two equal parts. All mice which received as an average of their third, fourth and fifth tests, grades not exceeding 2.4 are considered tame and non-savage. Those whose averages of these tests were equal to or between

2.5 and 5, are considered wild and savage. It is thus seen by this arrangement that four distinct groups are possible, i.e., a mouse would be found in one of the four classes, viz: wild and savage (w-s), wild and non-savage (w-n), tame and savage (t-s), tame and non-savage (t-n). Since the averages of the tests of the wild parental stock were greater than 2.5 grade

TABLE 33

*Summary of Results of Third Generation Hybrids, F<sub>3</sub>, of Series A, from Matings of Parental Generation, Tame Female with Wild Male*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 5													
Range of tests, 5													
Average age in days:													
First test, 38.0	First test.....	3.83			1	5		3.83			3	1	2
Last test, 112.0	Average 1 and 2 ..	3.16		1	2	3		3.41			3	2	1
6 F <sub>2</sub> a Males and Females	Average all.....	2.6		3	3		2.4			4	1	1	
	Average 3, 4 and 5.....	2.22	1	2	3		1.72	1	3	2	1		
	Last test.....	1.83	1	2	2		1.66	1	2	2	1		
Average number tests, 5													
Range of tests, 5													
Average age in days:													
First test, 38	First test.....	3.66		1	2		3.66			2		1	
Last test, 97	Average 1 and 2 ..	2.83		1	1	1	3.16			2	1		
3 F <sub>2</sub> a Males	Average all.....	2.66		2	1		2.26			2	1		
	Average 3, 4 and 5 .....	2.55	1	2			1.66	1	1	2			
	Last test.....	2.0	1	1	1		2.0	1	1	1			
Average number tests, 5													
Range of tests, 5													
Average age in days:													
First test 38	First test.....	4.0			3		4.0			1	1	1	
Last test, 127	Average 1 and 2 ..	3.5		1	2		3.66			1	1	1	
3 F <sub>2</sub> a Females	Average a l.....	2.53		1	2		2.53			2		1	
	Average 3, 4 and 5 .....	1.88	1	1	1		1.77	2	1				
	Last test .....	1.66	1	1	1		1.33	2	1				

they are classed as wild and savage, and similarly the tame parental stock are tame and non-savage inasmuch as their averages never exceeded 2.4 grade.

From the matings of the parental stock and of the first and second hybrid generations in the general and selected breeding eleven different sets are to be found. These include all the

different matings used in this study. In addition to the symbols they are designated in the tables by the Roman numerals which precede them in the following list.

- I. Female wild and savage  $\times$  male wild and savage ( $\text{♀ w-s} \times \text{♂ w-s}$ )
- II. Female wild and savage  $\times$  male wild and non-savage ( $\text{♀ w-s} \times \text{♂ w-n}$ )
- III. Female wild and non-savage  $\times$  male wild and savage ( $\text{♀ w-n} \times \text{♂ w-s}$ )

TABLE 34  
*Summary of Results of Third Generation Hybrids,  $F_3$ , of Series A, from Matings of Parental Generation, Wild Female with Tame Male*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 4.21													
Range of tests, 3-5	First test.....	3.5		2	4	5	3.92				5	5	4
Average age in days:													
First test, 41.64	Average 1 and 2..	3.25		2	5	5	2.36			1	4	5	4
Last test, 103.22	Average all.....	2.89		7	4	3	3.05		1	2	5	4	2
14 $F_2$ Males and Females	Average 3, 4 and 5.....	2.58	1	6	2	5	2.54	1	1	3	5	2	2
	Last test.....	2.64	3	3	4	4	2.66	2	2	5	1	4	
Average number tests, 3.75													
Range of tests, 3-5	First test.....	3.0		2	3	2	1.4.12			3	3	3	
Average age in days:													
First test, 35.12	Average 1 and 2..	2.81		2	3	2	1.3.75			1	1	3	3
Last test, 98.66	Average all.....	2.56		4	4		3.26		1	2	3	2	
8 $F_2$ Males	Average 3, 4 and 5.....	2.28		5	1	2	2.71	1	1	3	1	2	
	Last test.....	2.62	1	3	2	2.2.33	1	1	1	3	1	3	
Average number tests, 4.83													
Range of tests, 4-5	First test.....	4.16			1	3	2.3.66			3	2	1	
Average age in days:													
First test, 48.66	Average 1 and 2 ..	3.83			2	3	1.3.41			3	2	1	
Last test, 105.5	Average all.....	3.24		3	3		2.82			2	3	1	
6 $F_2$ Females	Average 3, 4 and 5.....	2.82	1	1	1	3	2.41	1	1	2	2	1	
	Last test	2.66	2	2	2	2.83	1	1	1	2	1	1	

- IV. Female wild and savage  $\times$  male tame and non-savage ( $\text{♀ w-s} \times \text{♂ t-n}$ )
- V. Female tame and non-savage  $\times$  male wild and savage ( $\text{♀ t-n} \times \text{♂ w-s}$ )
- VI. Female wild and non-savage  $\times$  male wild and non-savage ( $\text{♀ w-n} \times \text{♂ w-n}$ )
- VII. Female wild and non-savage  $\times$  male tame and non-savage ( $\text{♀ w-n} \times \text{♂ t-n}$ )
- VIII. Female tame and non-savage  $\times$  male wild and non-savage ( $\text{♀ t-n} \times \text{♂ w-n}$ )
- IX. Female tame and non-savage  $\times$  male tame and non-savage ( $\text{♀ t-n} \times \text{♂ t-n}$ )
- X. Female tame and non-savage  $\times$  male tame and savage ( $\text{♀ t-n} \times \text{♂ t-s}$ )
- XI. Female wild and savage  $\times$  male tame and savage ( $\text{♀ w-s} \times \text{♂ t-s}$ )

A general summary of the results of the three hybrid generations, according to the above arrangements, is presented in table 38. The first column of this table, beginning at the top, gives the following values for Series A of the first hybrid generation: (a) number of litters, (b) total number of mice, (c) number of mice which were wild and savage, (d) number which were

TABLE 35

*Summary of Results of Third Generation Hybrids, F<sub>3</sub>, of Series B, from Matings of Parental Generation, Tame Female with Wild Male*

	WILDNESS						SAVAGENESS						
	Distribution of mice in grades:						Distribution of mice in grades:						
	Av.	0	1	2	3	4	5	Av.	0	1	2	3	4
Average number tests, 4.62													
Range of tests, 4-5	First test.....	4.0			1	9	1	5.0					11
Average age in days:													
First test, 44.09	Average 1 and 2..	3.77			2	6	3	4.5					4 7
Last test, 87.12	Average all .....	3.9			5	4	2	4.37					1 5 5
11 F <sub>2</sub> b Males and Females	Average 3, 4 and 5	4.0			2	6	3	4.27					1 6 4
	Last test.....	3.72			1	3	5	2 4.5					1 4 6
Average number tests, 4.8													
Range of tests, 4-5	First test.....	4.0			1	4	5.0						5
Average age in days:													
First test, 44.6	Average 1 and 2..	3.8			1	2	2	4.6					2 3
Last test, 86.25	Average all .....	4.08			2	1	2	4.62					2 3
5 F <sub>2</sub> b Males	Average 3, 4 and 5.....	4.2			1	1	3	4.64					2 3
	Last test.....	3.8			1	1	1	2 4.75					1 4
Average number tests, 4.5													
Range of tests, 4-5	First test.....	4.0			5	1	5.0						6
Average age in days:													
First test, 43.66	Average 1 and 2	3.75			1	4	1	4.41					2 4
Last test, 88.0	Average all .....	3.74			3	3	4	4.14					1 3 2
6 F <sub>2</sub> b Females	Average 3, 4 and 5.....	3.73			1	5	3	3.93					1 4 1
	Last test.....	3.66			2	4	2	4.25					1 3 2

wild and non-savage, (e) number which were tame and savage, (f) number which were tame and non-savage. Immediately below this are the numbers for the males which in turn are followed by the numbers for the females. Following these values are the numbers of mice of this series which, according to the foregoing classification were, respectively, wild, tame, savage.

and non-savage. The number of mice which were considered wild is found by adding the number of wild and savage and the number of wild and non-savage found in the first division of the table. Likewise the total number of tame mice is the sum of the tame-savage and the tame-non-savage. The

TABLE 36

*Summary of Results of Third Generation Hybrids, F<sub>3</sub>, of Series B, from Matings of Parental Generation, Wild Female with Tame Male*

	WILDNESS						SAVAGENESS						
	Av.	Distribution of mice in grades:					Av.	Distribution of mice in grades:					
		0	1	2	3	4		0	1	2	3	4	
Average number tests, 4.64													
Range of tests, 3-5	First test.....	3.64			7	5	24.5				2	3	9
Average age in days:													
First test, 42.35	Average 1 and 2..	3.59		1	4	6	34.25				2	5	7
Last test, 82.63	Average all.....	3.46		2	5	7	3.43			3	3	6	2
14 F <sub>2</sub> b Males	Average 3, 4 and												
and Females	5.....	3.36	1	2	4	5	22.81	2	3	3	2	4	2
	Last test.....	3.14	1	3	5	2	32.63	2	3	3	2	1	3
Average number tests, 4.54													
Range of tests, 3-5	First test.....	3.63			6	3	24.54				1	3	7
Average age in days:													
First test, 42.09	Average 1 and 2..	3.95		1	3	6	14.19				2	4	5
Last test, 76.0	Average all.....	3.52		2	5	4	3.32			3	2	5	1
11 F <sub>2</sub> b	Average 3, 4 and												
Males	5.....	3.2	1	2	3	3	22.62	2	3	2	2	2	2
	Last test.....	2.9	1	3	4	1	22.63	2	2	3	1		3
Average number tests, 5													
Range of tests, 5	First test.....	3.66			1	2	4.33				1		2
Average age in days:													
First test, 34.	Average 1 and 2..	4.33			1		24.5				1		2
Last test, 100.33	Average all.....	3.26				3	3.8				1	1	1
3 F <sub>2</sub> b	Average 3, 4 and												
Females	5.....	3.88		1	2	3.23		1	1	1	1	2	
	Last test.....	4.0		1	1	1.366							

sum of the wild-savage and the tame-savage equals the total number which were savage, while the sum of the wild and non-savage mice and the tame and non-savage gives the number which were non-savage: In the second column are given the percentages which indicate what part of the total number of mice are the various numbers. The third and fourth column

give these values for Series B of the  $F_1$  hybrids. Then follow in order similar values for Series A and B of the  $F_2$  and  $F_3$ .

The chief value of this table is to show the similarity in the results of the three generations. With the exception of the results of the males and females (first section, table 38) and of the males of  $F_{2a}$ , the percentages for the four classes in each division of the table range from highest to lowest in the following order: wild-savage, wild-non-savage, tame-non-savage,

TABLE 37  
*General Summary of Tables 25 to 36 Inclusive*

	TAME FEMALE X WILD MALE				WILD FEMALE X TAME MALE			
	Series A		Series B		Series A		Series B	
	Averages	Sex testing highest	Averages	Sex testing highest	Averages	Sex testing highest	Averages	Sex testing highest
<i>Hybrids <math>F_1</math></i>								
Wildness								
All tests.....	3.15	Female	3.54	Female	3.36	Male	3.35	Female
Tests, 3, 4, 5.....	2.7	Female	3.14	Female	2.93	Male	3.16	Female
Savageness								
All tests.....	2.79	Male	2.8	Female	2.96	Female	3.25	Female
Tests, 3, 4, 5.....	2.06	Female	2.21	Female	2.42	Female	2.73	Female
<i>Hybrids <math>F_2</math></i>								
Wildness								
All tests.....	2.92	Female	3.72	Female	3.10	Female	2.92	Female
Tests, 3, 4, 5.....	2.57	Female	3.54	Female	2.40	Female	2.60	Female
Savageness								
All tests.....	3.21	Female	3.9	Female	2.76	Male	3.2	Female
Tests, 3, 4, 5.....	1.96	Female	3.55	Female	2.04	Female	2.77	Female
<i>Hybrids <math>F_3</math></i>								
Wildness								
All tests.....	2.6	Male	3.9	Male	2.89	Female	3.46	Male
Tests, 3, 4, 5.....	2.22	Male	4.0	Male	2.58	Female	3.36	Female
Savageness								
All tests.....	2.4	Female	4.37	Male	3.05	Male	3.43	Female
Tests, 3, 4, 5.....	1.72	Female	4.27	Male	2.54	Male	2.81	Female

tame-savage. The order for the males and females of  $F_{2a}$  is tame-non-savage, wild-savage, wild-non-savage, tame-savage. This change from the order of the remaining hybrids is caused by the great number of tame-non-savage males which is almost twice as great as the combined number of wild-savage and wild-non-savage. The percentage of tame-savage remains the smallest among the males but the numbers of wild-savage and wild-non-savage are the same, each being 24. It is to be noted that the percent of wild-savage females in each group

is much in excess of that of the males, especially in the case of the F<sub>2</sub>b where they are, respectively, 0.469 and 0.224.

In table 39 appear the results of the F<sub>1</sub> hybrids divided according to the matings of the parental stock, i.e., wild female and tame male, or tame female and wild male. With the exception of the results from the matings of tame female with wild male in Series A, the percentages follow the order noted in the

TABLE 38  
*General Summary of the Individual Inheritances of the Three Hybrid Generations*

		F <sub>1</sub> HYBRIDS				F <sub>2</sub> HYBRIDS				F <sub>3</sub> HYBRIDS			
		Series A		Series B		Series A		Series B		Series A		Series B	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Litters.....		17		50		44		52		25		13	
Mice total.....		99		216		212		269		114		49	
Males and Females	w-s	45	0.454	139	0.643	70	0.33	169	0.628	64	0.561	34	0.693
	w-n	32	0.323	54	0.25	56	0.264	62	0.23	19	0.165	11	0.224
	t-s	5	0.051	30	0.013	14	0.066	7	0.022	13	0.113	1	0.02
	t-n	17	0.171	20	0.092	72	0.339	31	0.115	18	0.157	3	0.061
Males.....	w-s	16	0.161	51	0.236	24	0.113	71	0.264	30	0.263	11	0.224
	w-n	11	0.111	25	0.115	24	0.113	33	0.122	13	0.113	7	0.142
	t-s	4	0.04	2	0.009	6	0.028	4	0.014	7	0.061	1	0.02
	t-n	9	0.09	18	0.083	46	0.216	26	0.097	12	0.105	3	0.061
Females.....	w-s	29	0.292	88	0.407	46	0.216	98	0.364	34	0.298	23	0.469
	w-n	21	0.212	29	0.134	32	0.15	29	0.107	6	0.052	4	0.081
	t-s	10	0.01	10	0.004	8	0.037	30	0.011	6	0.052		
	t-n	8	0.08	2	0.009	26	0.122	5	0.018	6	0.052		
Males and females.....	Wild	77	0.777	193	0.893	126	0.594	231	0.858	83	0.726	45	0.917
	Tame	22	0.222	23	0.105	86	0.405	38	0.137	31	0.270	4	0.081
	Sav.	50	0.505	142	0.656	84	0.396	176	0.65	77	0.674	35	0.713
	Non-sav.	49	0.494	74	0.342	128	0.603	93	0.345	37	0.322	14	0.285

F<sub>1</sub> generation in table 38, namely, wild-savage, wild-non-savage, tame-non-savage, tame-savage. In the case of this exception the non-savageness of the tame female seems to have exerted a greater influence over the offspring than usual, especially with the females. The wild-non-savage class is the greater among the females and the tame-non-savage among the males. In the combined results of the males and females the wild-non-savage mice are in greater numbers, the wild-savage

and tame-non-savage are equal and the tame-savage are, as usual, the least in numbers. This apparent influence of the tame female over the offspring is not shown in the like mating in Series B, since only 0.08 of the total number of mice (sum of t-s and t-n) are found in the tame classes and 0.328 (sum of w-n and t-n) are in the non-savage classes. These percentages

TABLE 39

*Summary of Matings of Parental Generation and Results of Individual Inheritance of F<sub>1</sub> Hybrids, Series A and B*

		P MATING							
		Series A				Series B			
		IV ♀ W-S × ♂ T-N		V ♀ T-N × ♂ W-S		IV ♀ W-S × ♂ T-N		V ♀ T-N × ♂ W-S	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Litters.....		9		8		13		37	
Mice total.....		54		45		55		161	
Males and females.....	w-s	32	0.592	13	0.288	33	0.60	106	0.658
	w-n	17	0.314	15	0.333	12	0.218	42	0.26
	t-s	1	0.018	4	0.088	1	0.018	2	0.012
	t-n	4	0.074	13	0.288	9	0.163	11	0.068
Males.....	w-s	12	0.222	4	0.088	11	0.20	40	0.249
	w-n	8	0.148	3	0.066	5	0.091	20	0.124
	t-s	1	0.018	3	0.066	1	0.018	1	0.006
	t-n	2	0.037	7	0.155	9	0.163	9	0.056
Females.....	w-s	20	0.37	9	0.20	22	0.48	66	0.409
	w-n	9	0.166	12	0.266	7	0.127	22	0.136
	t-s			1	0.022			1	0.006
	t-n	2	0.037	6	0.133			2	0.012
Males and females.....	Wild	49	0.906	28	0.621	45	0.818	148	0.918
	Tame	5	0.259	17	0.376	10	0.181	13	0.08
	Sav.	33	0.777	17	0.376	34	0.618	108	0.67
	Non-sav.	21	0.388	28	0.621	21	0.381	53	0.328

are in each case higher in the opposite mating (wild female with tame male).

The results of the matings of the mice of Series A, F<sub>1</sub>, are presented in table 40, and those of Series B in table 41. The division of the number of mice of any generation into various groups according to the grades of wildness and savageness of

their parents lessens the value of each group, as far as mere numbers are concerned, in proportion as the numbers comprising each group are lessened. In this case, however, the loss seems to be more than counteracted by the value of the demonstrated tendency that a difference in the grade of wildness and savageness of the hybrid parents seems to make some, though

TABLE 40  
*Summary of Matings of F<sub>1</sub> Hybrids, Series A, and Results of Individual Inheritances of F<sub>2</sub> Hybrids, Series A*

		F <sub>1</sub> MATINGS														
		I ♀ W-S ♂ W-S		II ♀ W-S ♂ W-N		III ♀ W-N ♂ W-S		IV ♀ W-S ♂ T-N		VI ♀ W-N ♂ W-N		VII ♀ W-N ♂ T-N		XI ♀ W-S ♂ T-S		
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	
Litters...																
Mice total		7		8		7		7		8		4		3		
		35		39		39		30		33		23		13		
Males and females.	{	w-s	17	0.485	60	0.153	13	0.333	80	0.266	13	0.393	80	0.347	50	0.383
		w-n	40	0.114	180	0.461	70	0.179	70	0.233	90	0.272	60	0.26	60	0.461
		t-s	30	0.085			40	0.102	50	0.166	10	0.03				
		t-n	110	0.314	150	0.383	150	0.383	100	0.333	100	0.303	90	0.391	20	0.153
Males ...	{	w-s	8	0.228	10	0.025	20	0.051	30	0.10	70	0.212	30	0.13		
		w-n	30	0.085	70	0.179	20	0.051	40	0.133	40	0.121	30	0.13	10	0.076
		t-s	10	0.028			20	0.051	30	0.10						
		t-n	50	0.143	90	0.23	100	0.256	70	0.233	80	0.242	50	0.217	20	0.153
Females ..	{	w-s	90	0.257	50	0.128	110	0.282	50	0.166	60	0.181	50	0.217	50	0.383
		w-n	10	0.028	110	0.282	50	0.128	30	0.10	40	0.121	30	0.13	50	0.383
		t-s	20	0.057			20	0.051	20	0.066	20	0.06				
		t-n	60	0.171	60	0.153	50	0.128	30	0.10	20	0.06	40	0.173		
Males and females.	{	Wild	21	0.599	24	0.614	20	0.512	150	0.499	220	0.665	140	0.607	110	0.844
		Tame	140	0.399	150	0.383	190	0.485	150	0.499	110	0.333	90	0.391	20	0.153
		Sav.	20	0.57	60	0.153	170	0.435	130	0.432	140	0.423	80	0.347	50	0.383
		Non-sav.	150	0.428	330	0.844	220	0.562	170	0.566	190	0.575	150	0.651	80	0.614

not a striking difference, in the grade of wildness and savageness of the offspring. If the results given in table 40 are considered, it would seem fairly reasonable to expect more of the mice from Mating I. (♀ W-S X ♂ W-S) to be wild and savage than tame and non-savage since the parents both graded wild and savage. This seems to be the case, at least to some extent, since the percentage of wild mice and the percentage of

savage mice are in excess, although in this particular instance one third of the offspring were considered tame and non-savage.

In Mating II ( $\text{♀ W-S} \times \text{♂ W-N}$ ) and Mating III ( $\text{♀ W-N} \times \text{♂ W-S}$ ) wherein one parent in each mating was non-savage the majority of the offspring, according to the above statement, should be wild since each parent was wild, while the number

TABLE 41  
*Summary of Matings of  $F_1$  Hybrids, Series B, and Results of Individual Inheritances of  $F_2$  Hybrids, Series B*

		F <sub>1</sub> MATINGS											
		I ♀ W-S ♂ W-S		II ♀ W-S ♂ W-N		IV ♀ W-S ♂ T-N		VI ♀ W-N ♂ W-N		VII ♀ W-N ♂ T-N		VIII ♀ T-N ♂ W-N	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Litters.....		28		7		1		5		10		1	
Mice total.....		147		34		7		22		53		6	
Males and females	w-s	110	0.748	17	0.50	40	0.571	80	0.363	25	0.471	50	0.833
	w-n	21	0.142	50	0.147	20	0.285	11	0.50	22	0.415	10	0.166
	t-s	4	0.027	30	0.088								
	t-n	12	0.081	90	0.264	10	0.142	30	0.136	6	0.113		
Males.....	w-s	44	0.299	60	0.176	20	0.285	40	0.181	13	0.245	20	0.333
	w-n	13	0.088	10	0.029	20	0.285	60	0.272	10	0.188	10	0.166
	t-s	20	0.013	20	0.058								
	t-n	9	0.06	80	0.235	10	0.142	30	0.136	5	0.094		
Females.....	w-s	66	0.449	11	0.323	20	0.285	40	0.181	12	0.226	30	0.50
	w-n	80	0.054	40	0.117			50	0.227	120	0.226		
	t-s	20	0.013	10	0.029								
	t-n	30	0.02	10	0.029					10	0.018		
Males and females	Wild	131	0.89	22	0.647	60	0.856	190	0.863	470	0.886	60	0.999
	Tame	16	0.108	12	0.325	10	0.142	30	0.136	60	0.113		
	Sav.	114	0.775	20	0.588	40	0.571	80	0.363	250	0.471	50	0.833
	Non-sav.	33	0.223	14	0.411	30	0.427	140	0.636	280	0.528	10	0.166

of savage and non-savage should be about equally divided. From the last section of table 40 it is seen that the number of wild does exceed the number of tame but in the case of Mating II by only one mouse. The savage and non-savage are fairly well divided (17 and 22 respectively) in Mating III but in Mating II the non-savage are over five times as numerous as the savage.

TABLE 42  
*Summary of Matings of F<sub>1</sub> Hybrids, Series A, and Results of Individual Inheritances of F<sub>3</sub> Hybrids, Series A*

F <sub>1</sub> MATINGS													
		♀ W-S			♀ W-N			♀ W-S			♀ T-N		
		Number	Percent										
Litters.....		1	1	4	1.0	20	0.434	1	0.333	1	0.25	7	0.636
Mice total.....		3	5	4	1.0	13	0.282	3	0.666	1	0.25	2	0.181
W-s		2	0.666	5	1.0	20	0.434	1	0.333	1	0.25	7	0.714
W-n		1	0.333	3	0.605	3	0.065	2	0.666	1	0.09	1	0.035
t-s		1	0.333	10	0.217	10	0.217	1	0.333	2	0.50	1	0.09
t-n		1	0.333	4	0.80	1	0.25	11	0.239	1	0.25	1	0.09
Males and females.....		W-s	1	0.333	1	0.20	3	0.75	9	0.195	2	0.666	
Males.....		W-n	1	0.333	1	0.20	7	0.152	2	0.666	1	0.25	
Females.....		t-s	1	0.333	1	0.20	3	0.75	9	0.195	1	0.333	
Males and females.....		t-n	1	0.333	1	0.20	7	0.152	2	0.666	1	0.25	
Wild		2	0.666	5	1.00	4	1.00	33	0.716	1	0.333	2	0.666
Tame		1	0.333	5	1.00	4	1.00	13	0.282	2	0.666	1	0.333
Sav.		1	0.333	5	1.00	4	1.00	23	0.499	3	0.999	3	0.999
Non-sav.													

In Mating IV ( $\text{♀ W-S} \times \text{♂ T-N}$ ) in which case the male parent is tame and non-savage the percentages for wildness and tameness are identical, while those for savageness and non-savageness are 0.432 and 0.566 respectively. This seems to indicate that the hereditary influence of the parents was about equally divided between wildness and tameness and between savageness and non-savageness.

TABLE 43  
*Summary of Matings of  $F_2$  Hybrids, Series B, and Results of Individual Inheritances of  $F_2$  Hybrids, Series B*

		$F_2$ MATINGS					
		I ♀ W-S X ♂ W-S		II ♀ W-S X ♂ W-N		IX ♀ T-N X ♂ T-N	
		Number	Per cent	Number	Per cent	Number	Per cent
Litters.....		10		1		2	
Mice total.....		41		2		6	
Males and females.....	w-s	27	0.658	2	1.00	5	0.833
	w-n	10	0.243			1	0.166
	t-s	1	0.034				
	t-n	3	0.073				
Males.....	w-s	9	0.219			2	0.333
	w-n	7	0.17				
	t-s	1	0.024				
	t-n	3	0.073				
Females.....	w-s	18	0.439	2	1.00	3	0.50
	w-n	3	0.073			1	0.166
	t-s						
	t-n						
Males and females.....	Wild	37	0.901	2	1.00	6	0.999
	Tame	4	0.097				
	Sav.	28	0.682	2	1.00	5	0.833
	Non-sav.	13	0.316			1	0.166

In Mating VI ( $\text{♀ W-N} \times \text{♂ W-N}$ ) the wildness percentage is 0.665 and the non-savage 0.575 in comparison with 0.333 for tameness and 0.432 for savageness. The effect of the grading in the parents seems to be here also quite apparent.

The percentage for non-savageness in Mating VII ( $\text{♀ W-N} \times \text{♂ T-N}$ ) is 0.651 in comparison with 0.347 for savageness. While this seems to show the effect of the non-savageness of the parents, there was no equalization of wildness and tameness as the percentages for these are 0.607 and 0.391 respectively.

In the results of the tests of the 13 mice from Mating XI ( $\text{♀ W-S X ♂ T-S}$ ) there is a contradiction of the results in the preceding matings because, though both parents were savage, 8 of the offspring were non-savage and 5 savage.

From the last division of table 41 similar results to those just noted in the preceding table may be seen to exist fairly regularly throughout the matings from which came the  $F_2b$  hybrids. The exceptions in this table are found in Matings IV, VII, and VIII. In Mating IV ( $\text{♀ W-S X ♂ T-N}$ ) the savage and non-savage offspring are rather evenly proportioned but the wild exceed the tame by 6 to 1. In Mating VII ( $\text{♀ W-N X ♂ T-N}$ ) the non-savage are slightly more numerous than the savage but, as in Mating IV, the wild are almost 8 times greater in numbers than the tame. Likewise the 6 mice from Mating VIII ( $\text{♀ T-N X ♂ W-N}$ ) show practically opposite results of inheritance since all 6 were in the wild class and the proportion of non-savage to savage was 1 to 5.

In tables 42 and 43 the summaries of the tests of the  $F_3a$  and  $F_3b$  hybrids are presented. Evidence that the grade of wildness and savageness existent in the parent tends to produce a similar grade in the offspring is to be found in the results of Mating I of both tables, in the results for wildness and tameness in Mating II of each table, and in Mating III of table 42, in the results for savageness and non-savageness in Mating IV, and also in the complete results of Mating VI and VII of this same table.

The exceptions in the case of Mating IX ( $\text{♀ T-N X ♂ T-N}$ ) of both series and of Mating X ( $\text{♀ T-N X ♂ T-S}$ ) of Series A (table 42) are interesting inasmuch as the number of wild in the offspring is in excess of the number of tame although both parents were in each case classed as tame. The number of savage individuals exceeds that of the non-savage in Mating IX although both parents were non-savage. This is likewise true in Mating VIII ( $\text{♀ T-N X ♂ W-N}$ ).

Mating I and Mating II are the only ones which appear throughout both series of the two hybrid generations. The results of these matings are presented in table 44 in order to enable a more comprehensive comparison. The blending heritable tendency that has been mentioned above may be more clearly noted in this table. It is rather well defined

TABLE 44  
*Summary of Mating I (♀ W-S X ♂ W-S) and Mating II (♀ W-S X ♂ W-N) of Both Series of  $F_1$ , and  $F_2$  Hybrids and Their Results in the  $F_2$  and  $F_3$  Hybrids of Both Series*

	MATING I (♀ W-S X ♂ W-S)						MATING II (♀ W-S X ♂ W-N)						
	$F_1$ Hybrids			$F_2$ Hybrids			$F_1$ Hybrids			$F_2$ Hybrids			
	Series A	Series B	Series A	Series B	Series A	Series B	Series A	Series B	Series A	Series B	Series A	Series B	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	
Litters.....	7	28	1	10	8	7	1	1	5	1.00	1	2	
Mice total.....	35	147	3	41	39	34	5	5	9	2	1.0	2	
W-S	17	0.485	110	0.748	2	0.666	27	0.658	6	0.153	17	0.50	
W-N	4	0.114	21	0.142	10	0.243	18	0.461	5	0.147			
T-S	3	0.085	4	0.027	1	0.024			3	0.088			
T-N	11	0.314	12	0.081	1	0.333	3	0.073	15	0.383	9	0.264	
W-S	8	0.228	44	0.299	1	0.333	9	0.219	1	0.025	6	0.176	4
W-N	3	0.085	13	0.083	7	0.17	7	0.179	1	0.029			
T-S	1	0.028	2	0.013	1	0.024			2	0.058			
T-N	5	0.143	9	0.06	1	0.333	3	0.073	9	0.23	8	0.235	
W-S	9	0.257	66	0.449	1	0.333	18	0.439	5	0.128	11	0.323	1
W-N	1	0.028	8	0.054	3	0.073	11	0.282	4	0.117			
T-S	2	0.057	2	0.013					1	0.029			
T-N	6	0.171	3	0.02					6	0.153	1	0.029	
Wild	21	0.599	131	0.89	2	0.666	37	0.901	24	0.614	22	0.647	5
Tame	14	0.399	16	0.103	1	0.333	4	0.097	15	0.383	12	0.352	1
Sav.	20	0.57	114	0.775	2	0.666	28	0.683	6	0.153	20	0.588	5
Non-sav.	15	0.428	33	0.223	1	0.333	13	0.316	33	0.844	14	0.411	

throughout the Series of Mating I but is noted only in the inheritance of wildness and tameness in Mating II, the proportion of savage and non-savage varying greatly in each case.

On the following pages there are presented three representative genealogical charts which give the number of litters from each mating, the classification of the mice and the numbers of the individual breeders.

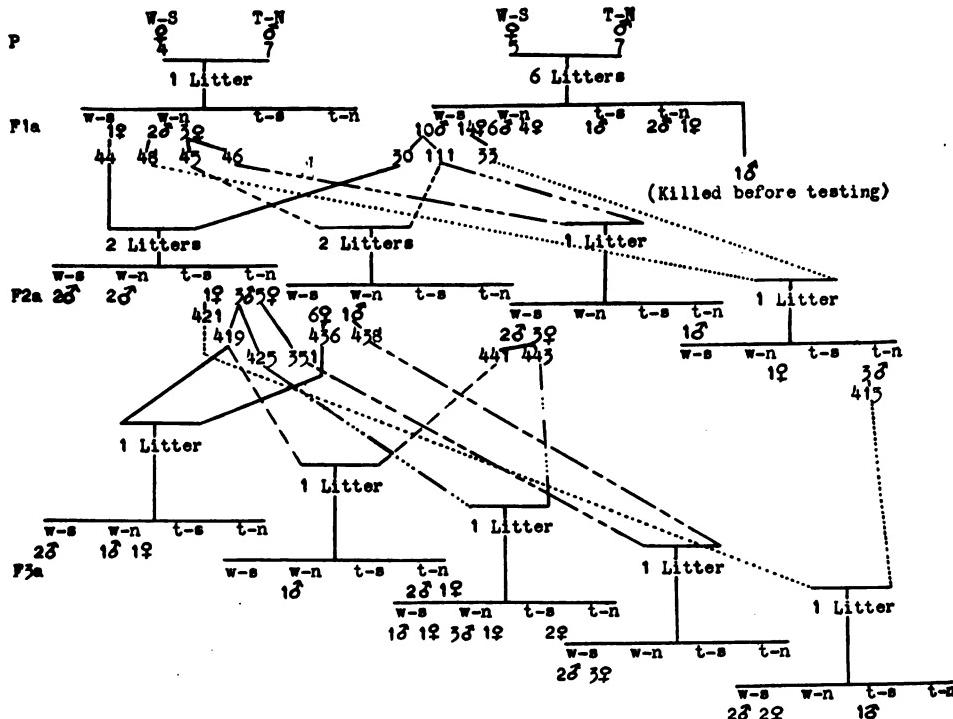
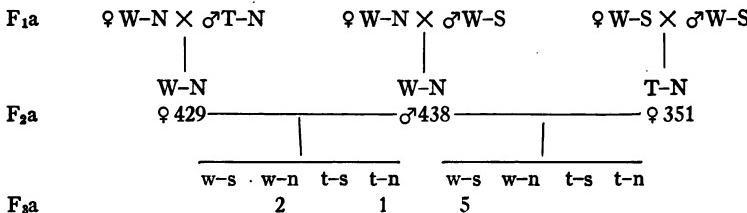


CHART 1.

A closer study of these charts reveals instances of inheritance which suggest the possibility of some slight segregation of the behavior-complexes under consideration. An example of this may be found in charts 1 and 2; graphically illustrated as follows:



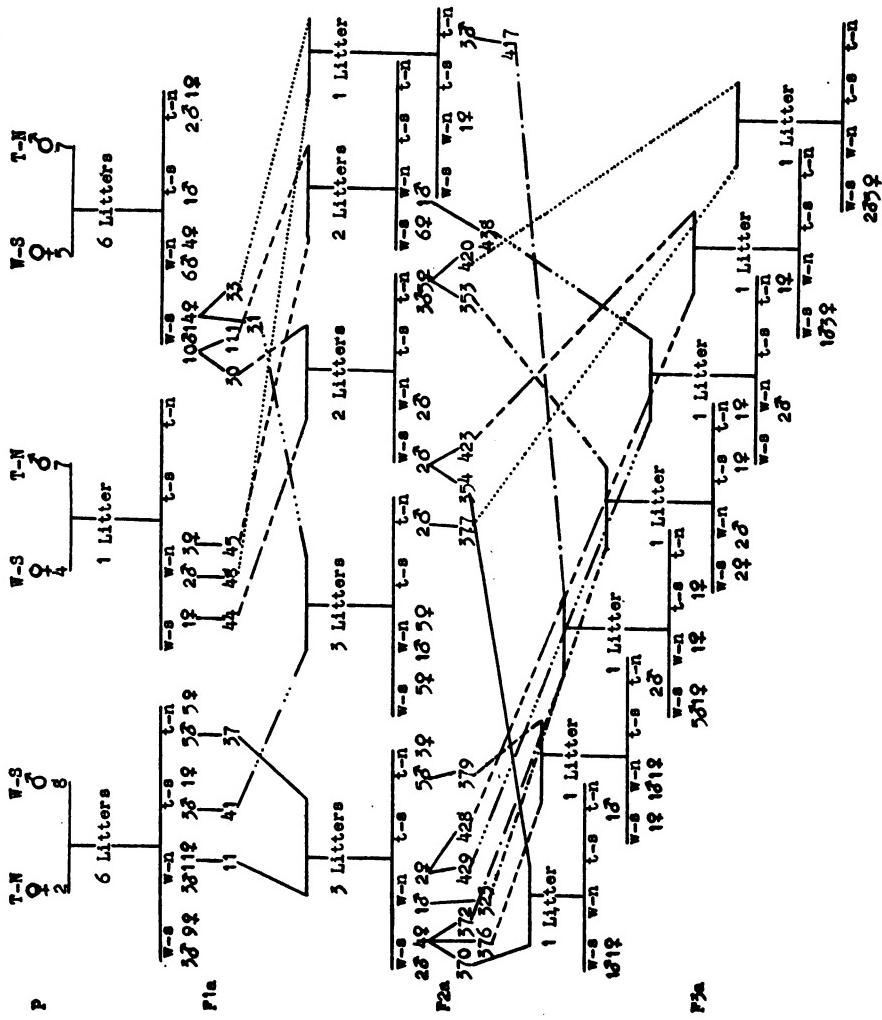


CHART 2.

As is seen here ♀ 429 came from a ♀ W-N X ♂ T-N mating, ♂ 438 from a ♀ W-N X ♂ W-S mating, and ♀ 351 from a ♀ W-S X ♂ W-S mating. From the mating of ♀ 429 (W-N) with ♂ 438 (W-N) there were 2 w-n and 1 t-n mice, while from the mating of ♀ 351 (T-N) with ♂ 438 (W-N) all the five mice were w-s. From the blending type of inheritance alone we would be led to expect a higher grading from the former

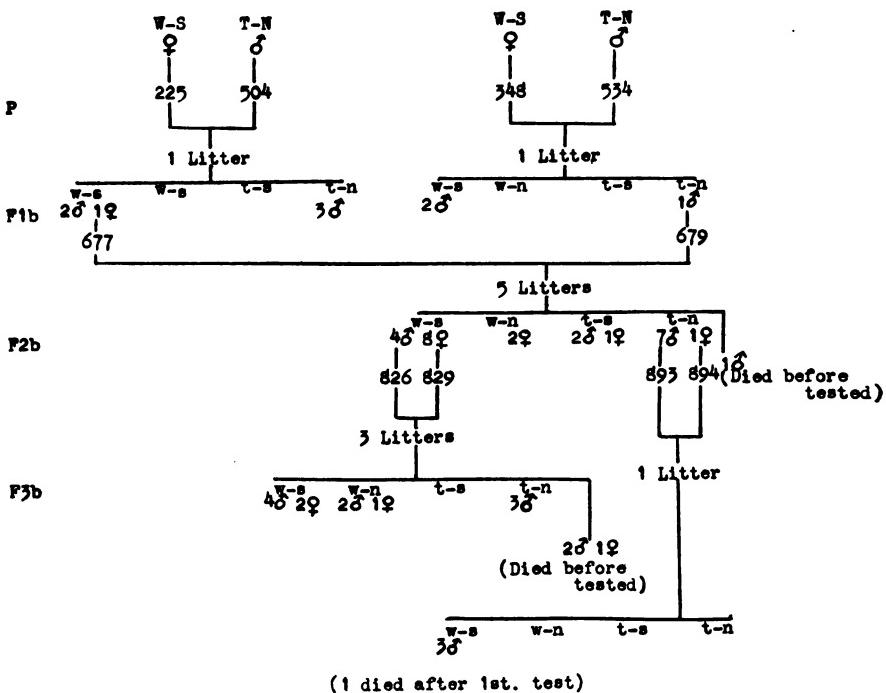


CHART 3.

mating than from the latter since both parents of the former were W-N, while the female in the latter was a T-N. To find a possible explanation we must go back to the preceding generation. Here we find in the case of the former mating an ancestry consisting of two female W-N, one male T-N and the other W-S, while in the case of the latter mating one female of the preceding generation was a W-N and the other female and the two males were each W-S. Other cases are to be found

where wildness seems to behave in a similar manner, as for instance, in chart 2 ( $F_2$ a, ♀ 420 with ♂ 377) and in chart 3 ( $F_2$ b, ♀ 894 with ♂ 893).

While the segregation of the various determining factors of savageness or wildness and their behavior as a recessive or, as it seems in some instances, a dominant, apparently explains the inheritance in these various crosses, the number of matings giving such results is comparatively few, hence, a statement more definite than a mere suggestion of a possibility must necessarily be left until a further study in this particular field has been made.

#### OBSERVATIONS ON "SINGING" IN MICE<sup>2</sup>

In the literature of animal behavior appear several references to the production by mice of sounds of musical quality.

The "singing" of mice is described variously by different writers. Lee (1878) states that it consists of a series of chirps at the rate of three or four per second. At the beginning of the series, the chirps are low but gradually they become louder. The "song" of one mouse this author likens to the sweet and varied warbling of a canary. Every note was "clear and distinct."

In referring to the same phenomenon, the naturalist Brehm (1896), attributes the following descriptions to various observers. One informant states that the "song" is an irregular mixture of chirps and trills with here and there a snarling, smacking sound followed by a low murmur. Another describes it as a twitter which is a mixture of long drawn squeaking and piping sounds which may be heard at a distance of twenty paces.

One observer noted the phenomenon only in the case of a female mouse while giving birth to young, while another observer states that only the male "sings."

The majority of those who have heard "singing" in mice have assumed that it is due to a diseased condition of the lungs or of the vocal organs, but conditions so diverse as pregnancy and parasites in the liver have also been suggested as causes.

<sup>2</sup> Revised note which appeared under heading of Singing Mice, *Journal of Animal Behavior*, 1912, ii, No. 5, pp. 363-366.

The writer desires to add, to the observations already reported, an additional record of "singing" mice. About the first of December, 1911, while working one evening in his study, he heard a series of sounds which seemed to come from above the ceiling. At the time, they were thought to resemble the soft chirping of a bird.

Shortly afterward, some wild mice were needed for breeding experiments and, by means of a trap, two mice, a male and a female, were captured in the room.

These animals, while being taken to the Harvard Psychological Laboratory, produced sounds like those previously heard in the room and they continued to do so at intervals after being placed in a laboratory cage. A few days after their capture, the male escaped. Inasmuch as the writer had not separated the two mice, placed each in a separate cage in a different part of the room, it is not possible to state whether the sounds were produced by both the mice or only by the female which remained and continued to "sing."

The female was mated with a tame mouse and produced, during the period of observation, five litters, thirty-three individuals. None of these offspring produced unusual sounds, nor did "singing" appear in the second or the third generations obtained from these hybrids.

The "singing" individual, so far as could be ascertained, was a common house mouse (*Mus musculus*). She was somewhat larger than the ordinary wild female, but no other external peculiarities were noted. She was extremely active and savage and her mate always bore the marks of her teeth. An attempt to mate her with a second tame male resulted in the death of the latter.

No definite time for "singing" was noted, except three or four days before and for six or seven days after the birth of a litter. It was observed, also, that the individual "sang" sometimes when frightened.

The sound is best described as a rapid whole-toned trill involving the tones C and D as is indicated below.



The quality of the tone resembled somewhat that of a fife or flute, but each tone ended with a slight throaty click. The tones were uttered at the rate of four or five per second in groups of varying size. Sometimes a group occupied one second, sometimes as long as ten seconds. As a rule, the tones of a group were not clear and distinct but, instead, were uttered so rapidly as to seem connected. The throaty click was more noticeable in the case of the last tone of a group. Often the "singing" would be continued for a period of ten or fifteen minutes with rests between groups.

The sound could readily be heard at a distance of fifteen or twenty feet, but it was difficult to localize it. The individual "sang" little during June, 1912, and it was not heard after July 1st, 1912. She died in August, apparently of old age.

During May, 1912, "singing" was again heard in the room in which the "singing" mice had earlier been captured, but efforts to capture the "singer" failed.

In January, 1913, a "singing" mouse was captured in the home of an Italian family in Brooklyn, New York. It was brought to the Laboratory and appears in the study described in this paper as female no. 475. There was captured with it a male, mouse no. 474, which, however, did not "sing." These two mice were mated and produced six of the wild individuals which were raised and tested and later used as breeders in Series B of the study in wildness and savageness inheritance. This "singer" was mated with a tame male, and again with a F<sub>2</sub> hybrid male but no "singer" appeared in these two litters, nor among the first, second, or third generation hybrids from the six wild offspring mated with tame individuals.

Later another "singer" was found on a farm in Michigan. It was sent to the Laboratory and proved to be a female also. No attempt was made at breeding this individual since it arrived just before the end of the study and there would not have been sufficient time for any observations to be made on the offspring.

The "singing" of these last two individuals was very much like that of the first, except that the mouse from Michigan did not "sing" as long at any time nor as frequently as did the other two.

The writer received several letters from different persons in various parts of the United States giving their observations

on this "singing" phenomenon in mice. In each case the observations had been merely casual and the reports gave no new information on the subject.

The results of this investigation, though by no means complete, indicate fairly definitely that this "singing" characteristic in mice is not heritable. From the fact that no males were captured that were definitely known to possess the characteristic, and the phenomenon in two of the three individuals observed was more often noted just before and after the birth of young, it seems quite possible that it is a characteristic peculiar to females and, perchance, due to a diseased condition or otherwise structural defect of the vocal organs, caused or, at least, accentuated by the birth of young.

#### SUMMARY AND CONCLUSIONS

1. When the grades of wildness and savageness attained by mice of each hybrid generation are considered collectively, the lowering of the average grades of wildness and savageness in the successive tests is gradual in each generation but is greatest in both wildness and savageness in the second hybrid generation. The greatest amount of difference in the grade of wildness for any two consecutive tests occurs between the second and third.
2. The mice of Series B, as a whole, graded higher than those of Series A in both wildness and savageness. This result does not indicate the presence of wild blood in the tame parents of the hybrids of Series A, and hence is directly opposed to the results Professor Yerkes obtained with the rats.
3. Savageness is more usually associated with wildness than with tameness.
4. The females, as a rule, attained higher grades in wildness and savageness than the males.
5. From the results of the tests of the first and second hybrid generations of Series A, it was found that, generally speaking, the older the mice the lesser the average grades in wildness and savageness attained by them in the five tests.
6. The decrease in the grades of wildness and savageness continues with the successive tests when the number of tests is increased to eight.
7. Age, frequency of tests, number of tests, and the presence of the experimenter in the room, each has a certain effect

in the lowering of the grade of wildness and savageness in the hybrids.

8. The hybrids of Series A from the matings of parental generation tame female with wild male became generally less wild and less savage in the succeeding generations, while the hybrids of Series B of this mating attained an increasingly higher average grade of wildness and savageness in the successive generations. The females of both series from this mating were more wild and savage in the first and second generations and the females of Series A more savage in the third generation than the males, the males of both series being more wild than the females in the third generation, while the males of Series B were also more savage than the females in this generation.

9. The average grades attained in wildness and savageness in the first generation hybrids of both series, from matings of parental generation wild female with tame male, were, as a rule, lowered in the second generation and then, in the third generation, raised almost to the height of the grades obtained in the first. The grades received by the females of both series from this mating are in excess of those obtained by the males except in the case of the males of Series A, which graded higher in wildness in the first generation and higher in savageness in the third generation than the females of Series A.

10. Under the conditions existing in this study it is very doubtful whether there was much, if any, difference in the inheritance of wildness and savageness by the hybrids due to the fact that one type of parental mating was wild female and tame male and the other, tame female and wild male.

11. When the individual mice are separated into the four classes; wild-savage, wild-non-savage, tame-savage, tame-non-savage, according to the average of the third, fourth and fifth tests for wildness or savageness being equal to or above 2.5 grade or below this, the wild and savage class, as a rule, represented the greatest number of mice, the wild and non-savage class the next highest, the tame and non-savage the next, and the tame and savage class the least number. The one exception to this is in the second generation hybrids of Series A, for which the order was as follows: (1) tame-non-savage, (2) wild-savage, (3) wild-non-savage, (4) tame-savage, where 1 represents the greatest number of mice and 4 the lowest.

12. The number of wild and savage females in each hybrid generation is always greater than the number of wild and savage males.

13. In the experiments in selective breeding it was generally to be noted that there was a tendency for the degree of wildness or savageness possessed by the parents to be reproduced in the offspring, that is, if both parents were wild, (the average of their third, fourth and fifth tests for wildness being equal to or exceeding 2.5 grade), in the majority of cases it would be found that the number of wild offspring was greater than that of tame, or if the parents were tame the greater number of offspring would be tame. The occasional isolated case in which this tendency did not maintain and where the results seem to indicate some particular combination of hereditary units is very interesting. It confirms the conviction of the writer that much more work is needed in this field before the precise manner of the inheritance of wildness and savageness in mice can be definitely stated. However, from this study it seems that the two behavior-complexes in question are the result of several different inheritance factors which follow the Mendelian rules.

14. Three female wild mice were found which possessed the "singing" property. No male was obtained which had this characteristic. This "singing" did not appear in any of the offspring to the third generation. It is evidently not inheritable, and quite possibly is a characteristic peculiar to females. The phenomenon seems to be associated in some way with the birth of young, and probably is caused by some structural defect or a diseased condition of the vocal organs.

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